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The Engineer

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PUBLIC NOTICES

TO BUILDERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 27th January, 1927, for the INSTALLATION of a HOT WATER SERVICE APPARATUS at the Head Post Office, Cardiff.
Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4441

The Director - General, India Store Department, Branch No. 16, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. 2000 SETS JUNCTION FISH-PLATES.
2. TWO PUMPING SETS for Tuticorin Water Supply, each 625 gallons per minute, 200ft. head, including ERECTION in India.

Tenders due on the 1st February, 1927, for No. 1, and on the 11th February, 1927, for No. 2.
Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 4494

Assistant Civil Engineer REQUIRED for the Port Harcourt Works, NIGERIA, for a tour of 12 to 18 months' service, with possible extension. Salary £480 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, must have had actual experience of Harbour Works Construction and be efficient Land and Marine Surveyors.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/15034. 4489

Engineer Required by the GOVERNMENT of NIGERIA for the AGRICULTURAL DEPARTMENT for two tours of 12 to 18 months' service, with possible extension, to sail early in April. Salary £840, rising to £920 a year by annual increments of £40. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 45 years of age, must possess special experience in well sinking and well boring, both through rock and sand.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/15,056. 4439

Test Assistant Required at the Royal Aircraft Establishment for general assistance to the scientific staff of the Wind Tunnel Section of the Aerodynamic Department. Candidates should have had an engineering training and preferably some experience in the use of delicate apparatus and the accurate recording of observations. Salary from 40s. and Civil Service bonus to 50s. and Civil Service bonus (present total remuneration 60s. 1d. to 70s. 4d. per week), depending on suitability. Ex-Service man preferred.—Write, quoting A. 142, to CHIEF SUPERINTENDENT, R.A.E., South Farnborough, Hants. 4434

Institution of Structural Engineers.
MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.
This Examination is held quarterly for candidates of and over 25 years of age having 10 years' practical experience, including time served in articles. It consists of a problem in design with a little additional work, which is carried out by the candidate at his own home. The NEXT EXAMINATION will be held on FEBRUARY 19th, and entries should reach me before February 14th. Syllabus and full particulars from the under-noted.
MAURICE G. KIDDY, F.I.S.A.,
Secretary.
10, Upper Belgrave-street, S.W. 1. 4479

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.SC. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to
THE REGISTRAR,
Armstrong College,
4329 Newcastle-upon-Tyne.

University College, Nottingham.
DEPARTMENT OF ENGINEERING.
The Council invites APPLICATIONS for the POSITION of LECTURER in MACHINE DRAWING and DESIGN.
Salary £280 for probationary first year, £300 if appointment then confirmed.
Further particulars and forms of application, which must be returned by January 31st, may be obtained from J. E. SHIMELD, Registrar. 4446

PUBLIC NOTICES

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 4347

Bengal-Nagpur Railway Company LIMITED.
The Directors are prepared to receive TENDERS for :—
(A) COLD-DRAWN STEEL BOILER TUBES.
(B) STEEL TYRES.
(C) COPPER FIRE-BOX PLATES.
(D) CAST STEEL AXLE-BOXES.
(E) PETROL TANK WAGONS.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, E.C. 2, on or after 13th January, 1927.
A fee of 20s. will be charged for Specification (A) and 10s. each for Specification (B), (C), (D), and (E), which are NOT returnable.
Tenders must be submitted not later than Noon in each case as follows :—
Specification (A) and (B), on Monday, 24th January, 1927.
Specification (C) and (D), on Tuesday, 25th January, 1927.
Specification (E), on Wednesday, 26th January, 1927.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the orders.
By Order of the Board,
R. C. VOLKERS,
4490 Secretary.

Bombay, Baroda and Central India Railway Company.
The Directors are prepared to receive up to Noon on Wednesday, 26th January, TENDERS for the SUPPLY of :—
STEEL MATERIAL (Channels, Angles, Plates, &c.).
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. B. YOUNG,
Secretary.
Offices: The White Mansion,
91, Petty France, S.W. 1.
10th January, 1927. 4437

PUBLIC NOTICES

City of Nottingham.
TO CONTRACTORS.
The General Purposes Committee are prepared to receive TENDERS from responsible contractors for the WIDENING of the BRIDGE carrying Perry-road over the L. and N.E. Railway at Basford, Nottingham.
General conditions of contract, specification and quantities may be obtained, and plans may be seen on and after Tuesday, January 11th, on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of £2, which will be returned on receipt of a bona fide Tender.
Sealed Tenders are to be delivered in the official envelope provided to the undersigned, not later than 6 p.m. on Tuesday, 25th January, 1927.
The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from firms having the necessary plant and experience and who conform with the conditions of the contract as regards paying the local standard rate of wages, &c., and with the working rules of the Nottingham district.
By Order,
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
7th January, 1927. 4456

County of London.
The London County Council invites TENDERS for the PURCHASE, DISMANTLING and REMOVAL of SIX WATER-TUBE BOILERS with ECONOMISERS, &c., at present installed in the Tramways Power Station at East Greenwich.
Particulars and form of Tender may be obtained from the General Manager of Tramways, Victoria Embankment, W.C. 2, who will also arrange facilities for the plant to be inspected between the hours of 9 a.m. and 5 p.m. on any weekday except Saturday.
Tenders must be delivered to the Clerk of the Council at The County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Monday, 31st January, 1927. No Tender received after that time will be considered.
The Council does not bind itself to accept the highest or any Tender.
MONTAGU H. COX,
4472 Clerk of the London County Council.

The Madras and Southern Mahratta Railway Company, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for :—
(1) 105,084 FEET TUBULAR POINT RODDING (MILD STEEL).
(2) SWITCHES and CROSSINGS.
Tenders are due in on Tuesday, 1st February, 1927, by 2 p.m. Tender forms obtainable at above address, fee One Guinea each, which is not returnable.
The Directors do not bind themselves to accept the lowest or any Tender. 4491

PUBLIC NOTICES

City of Manchester.
BARTON POWER STATION.
The Electricity Committee of the Manchester Corporation invite TENDERS for the following PLANT :
SPECIFICATION No. E. 53.—Supply, Delivery and Erection of Two Electrically Driven Circulating Water Pumps, complete with Motors, &c. Capacity 17,600 gallons per minute.
SPECIFICATION No. B. 54.—Supply, Delivery and Erection of Main Circulating Water and Exhaust Steam Pipes, Supports, &c.
Specifications and forms of Tender may be had on application to Mr. H. C. Lamb, Chief Engineer and Manager, Electricity Department, Town Hall, Manchester, on payment of a fee of One Guinea for each specification, which amount will be refunded on receipt of a bona fide Tender.
Tenders, duly endorsed and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than 10 a.m. on Monday, the 31st January, 1927.
The firms entrusted with the work will be required to enter into a contract to be prepared by the undersigned.
The Corporation do not bind themselves to accept the lowest or any Tender.
P. M. HEATH,
Town Clerk.
Town Hall, Manchester,
11th January, 1927. 4477

Poplar Borough Council.
The Council invites TENDERS for the RECONSTRUCTION and WIDENING of BOW COMMON-LANE BRIDGE, the WIDENING of the LIMEHOUSE CUT beneath, together with important Subsidiary Works.
The scheme involves :—
(a) A Steel Bridge with Abutments, Quay Walls and Towing Path Wall in Concrete.
(b) Towing Path Wall in Steel and Concrete.
The form of contract and schedules thereto with full instructions may be obtained from Mr. Harley Heckford, M. Inst. C.E., Borough Engineer, at the Council Offices, High-street, Poplar, upon payment of Three Guineas (returnable on receipt of a bona fide Tender).
Persons desirous of tendering may inspect the drawings between Ten and Four (Saturdays Ten to Twelve).
Contractors will be required to pay trade union rates of wages and observe trade union conditions.
Sealed Tenders, endorsed "Bow Common-lane Bridge," must be delivered to the undersigned not later than Noon, 2nd February, after which date and hour no Tender will be considered.
The Council does not bind itself to accept the lowest or any Tender.
H. E. DENNIS,
Town Clerk.
Council Offices, Poplar, E. 14,
10th January, 1927. 4444

Royal State Railways of Siam.
NOTICE.
Sealed TENDERS for the SUPPLY of CARRIAGE and WAGON BUFFERS with SIDE CHAINS, B.E. 2470, will be received by the Administration of the Royal State Railways of Siam, Bangkok, until Fourteen o'clock on the 15th April, 1927, at which place and hour the Tenders will be publicly opened and read.
Blank Tender forms, general conditions, specifications and drawings may be obtained from Messrs. C. P. SANDBERG, 40, Grosvenor-gardens, London, S.W. 1, upon payment of £1 per set, which sum will not be refunded.
Right is reserved to reject any or all Tenders, and to accept any Tender which is to the best interests of the Royal State Railways of Siam. 4433

State Electricity Commission OF VICTORIA, AUSTRALIA.
TENDERS are hereby INVITED for the MANUFACTURE, SUPPLY, and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, of TWO (2) STEAM BRIQUETTE PRESSES in accordance with Specification No. 27/4.
Copies of Tender form, specification and drawings, &c., will be available upon application to :—
The Agent-General for Victoria,
Victoria House, the Strand,
London, England :
And Herr J. Klitzing,
Bergwerksdirektor, Gruoe Marga,
Bei Senftenberg, Germany.
A preliminary deposit of £50 is to be lodged with Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered at the office of the undersigned in Melbourne not later than 28th February, 1927.
The Commission does not bind itself to accept the lowest or any Tender.
R. LIDDELOW,
Secretary.
22-32, William-street,
Melbourne, Australia. 4448

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PUBLIC NOTICES

The Bengal and North-Western
RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—
60 THIRD-CLASS BOGIE CARRIAGES,
240 PAIRS WHEELS AND AXLES,
as per specifications to be seen at the Company's offices.

Tenders, addressed to the undersigned and marked "Tender for Carriages," or as the case may be, with name of firm tendering, to be lodged not later than Noon on the 8th day of February, 1927.

For each specification a fee of £1 will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
W. B. IZAT,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2, January 6th, 1927. 4449

Tyne Improvement Commission.
NEW MOTOR ROAD FROM THE NEW QUAY AT THE RIVER WALL, ALBERT EDWARD DOCK, TO HOWDON-ROAD, NORTH SHIELDS.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a NEW MOTOR ROAD between the New Quay at Albert Edward Dock River Wall and Howdon-road, North Shields.

Copies of the form of Tender, conditions of contract, specification and drawing may be obtained on application to the undersigned on payment of a deposit of £2 2s., which sum will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Motor Road," and addressed to the Chairman, Tyne Improvement Commission, Newcastle-upon-Tyne, must be delivered at the undermentioned offices not later than Noon on Monday, the 7th day of February, 1927.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission Offices,
Bewick street, Newcastle-upon-Tyne,
10th January, 1927. 4447

Metropolitan Borough of
HAMMERSMITH.
ELECTRICITY DEPARTMENT.

The undermentioned superseded PLANT, installed at Hammersmith Electricity Works, is offered FOR SALE, viz., THREE BABCOCK and WILCOX BOILERS with SUPERHEATERS.

Specification and full particulars from the Engineer and Manager, Electricity Department, 85, Fulham Palace-road, London, W. 6.

The dismantling and removal of the plant to be carried out by the purchaser at his own expense and risk.

Offers must be submitted to the Town Clerk, Town Hall, Hammersmith, W. 6, endorsed "Tender for Old Boilers," not later than 4 p.m. on Friday, 21st January, 1927.

HUGH ROYLE,
Town Clerk.

Town Hall, Hammersmith, W. 6,
3rd January, 1927. 4357

Madras Port Trust.
An ASSISTANT MECHANICAL ENGINEER is REQUIRED for service under the MADRAS PORT TRUST, INDIA. Must possess a good general and technical education and hold either an Extra First Class or First Class Board of Trade Certificate as a Marine Engineer.

Candidates should not be more than 35 years of age (Public School men preferred), and must be qualified to supervise the maintenance and repair of the dredger, tugs, motor launches, hydraulic, electric and steam cranes and power plant, and locomotives and wagons, in use by the Port Trust. They should also have a knowledge of constructional steel work and electrical work.

SALARY.—Commencing at Rupees 650 per month, and rising by annual increments of Rs. 33 1-3 to Rs. 950, with Rs. 60 house allowance or free quarters, and Provident Fund benefits.

TERMS.—A three years' agreement in the first instance, of which the first six months will be on probation, with first-class free passage to Madras and home again on satisfactory termination of services. Appointment will be subject to passing a strict medical examination.

Applications may be made by letter only, and must contain a detailed record of candidates' career (with dates) in chronological order, including general and technical education, and must be received by the undersigned not later than 5th February, 1927.

RENDEL, PALMER and TRITTON,
4498 13, Dartmouth-street, Westminster, S.W. 1

The Assam - Bengal Railway
COMPANY, LIMITED.
PRODUCTION ENGINEER.

REQUIRED, a PRODUCTION ENGINEER for the Locomotive and Carriage and Wagon Repair Shops of the above Railway Company in India. Age between 25 and 35 years.

QUALIFICATIONS.—Candidates must have held a responsible administrative position in a large engineering works and be capable of completely reorganising a large works system and lay-out so as to improve output and reduce costs. They must be experienced in up-to-date production methods, and be able to initiate and control planning, rate fixing, progress, inspection and costing departments. A good knowledge of modern ganging methods and works stores procedure is essential.

SALARY.—Rs. 375 to 975 per calendar month (plus overseas allowance), according to age and qualifications.

TERMS.—A three years' agreement in the first instance and first-class free passage to India. The selected candidate will be required to pass a strict medical examination.

Particulars of candidates' careers, giving in chronological order (with dates) details of general and technical education, where apprenticeship or pupilage was served, and subsequent experience, and stating age and whether married or single, accompanied by copies only of testimonials, should be addressed to the undersigned not later than 28th January, 1927.

By Order of the Board,
THOS. C. BRETT,
Secretary.

11th January, 1927.
Bishopsgate House,
80, Bishopsgate, E.C. 2. 4484

The National Boiler and
GENERAL INSURANCE COMPANY, Limited, invite APPLICATIONS for the POSITION of an ASSISTANT MECHANICAL ENGINEER in the Head Office, Manchester. The duties will be both technical and commercial. Qualifications required :—Age 25 to 30; good education and address; recognised technical qualification, apprenticeship and practical experience, ability to write clearly and in good English. Salary offered £300 to £350 per annum.—Apply by letter only, stating age and giving full particulars of education, engineering training and experience, also enclosing copies of testimonials, to the CHIEF ENGINEER, National Boiler and General Insurance Co., Ltd., St. Mary's Parsonage, Manchester, marking the envelope "Assistant Engineer." 4465

West Midlands Joint Elec-
TRICITY AUTHORITY.
DRAUGHTSMEN.

APPLICATIONS are INVITED for POSITIONS of SENIOR and JUNIOR DRAUGHTSMEN for the following sections :—
1. Civil and Constructional.
2. Mechanical and Plant Lay-out.
3. Electrical and Switchgear.

in connection with large generating stations and transmission systems.

Remuneration in accordance with abilities and experience.

Applications, endorsed "Draughtsman," to be addressed to S. T. Allen, Chief Engineer and Manager, on forms which may be obtained from him.

(Signed) H. F. CARPENTER,
Clerk and Treasurer.

Phœnix Buildings, Dudley-road,
Wolverhampton, 7th January, 1927. 4459

PUBLIC NOTICES

County Borough of Brighton.
WATERWORKS DEPARTMENT.
TEMPORARY ENGINEERING ASSISTANT.

The Corporation invite APPLICATIONS for the APPOINTMENT of TEMPORARY ENGINEERING ASSISTANT in the Waterworks Department for a minimum period of 12 months at a salary of £7 per week.

Applicants must be good draughtsmen and have had considerable experience in the design and lay-out of large steam pumping plants, construction of service reservoirs, &c.

Applications, in the candidates' own handwriting, stating age, qualifications and experience, together with copies of three recent testimonials, should be sent to the undersigned not later than 26th January, 1927.

A. B. CATHCART, M. Inst. C.E.,
Waterworks Engineer.

Waterworks Offices,
12, Bond-street, Brighton. 4497

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a STRUCTURAL ENGINEER, to Fill a SENIOR POST with a British Firm in India, who have Structural Steel and General Engineering Works.

Should have A.M.I.C.E. or equivalent qualifications. Must have had good technical and practical training, also drawing-office, workshop and commercial experience. Age 30 to 35.

Good salary and prospects to a suitable man.
Address, P2632, The Engineer Office. P2632 A

WANTED, an ASSISTANT MANAGER of Good appearance and education, who has had marine engineering training and experience, for Ship Repairing Works on North-East Coast. Must be energetic, strict disciplinarian, capable of interviewing shipowners and superintendents, supervising work, and generally to assist the management. Age 25-30, commencing salary £300 per annum. Progressive, permanent post to suitable man.—State experience and give references, Box "G," Kidd's Advertising Agency, Middlesbrough. 4453 A

WANTED by Large Manufacturing Concern, a TECHNICAL ENGINEER. Good pay, excellent prospects. Must have experience and knowledge of Application of Rubber Goods to Shipbuilding, Mining and Chemical Trade. Knowledge of rubber unnecessary. Man appointed must have good experience and good presence. University or public school training an advantage, but not essential.—Address, 4462, The Engineer Office. 4462 A

WANTED for Large Yorkshire Colliery, Energetic MECHANICAL ENGINEER, with sound theoretical and practical training, qualified to Take Charge above and below ground of Plant and Machinery installed at a modern colliery. Steam, compressed air and electricity in use. Must be good organiser and controller of labour as well as competent engineer.—Address, stating age, salary required, qualifications and experience, P2627, The Engineer Office. P2627 A

WANTED, GENTLEMAN to REPRESENT MANUFACTURING FIRM. Must be brilliant salesman, good business experience, tact, and sound common sense absolutely necessary, well introduced to engineering and shipbuilding establishments. One each, London and Glasgow. Credentials and terms in confidence.—Address, P2633, The Engineer Office. P2633 A

WANTED, YOUNG ENGINEER, Having Had experience in designing and testing Grinding Mills for farm purposes. Must be good draughtsman and willing to live abroad. Excellent future for ambitious and energetic man of good character having necessary qualifications. Send full particulars.—Address, P2649, The Engineer Office. P2649 A

APPLICATIONS are INVITED from Unmarried ENGINEERS not over 35 years of age for Factory Construction and Equipment Work. First-class technical qualifications and good English. At least one other European language. Outline experience, in chronological order, giving general education, including proficiency in languages, technical training and detailed drafting and practical experience. State age and commencing salary and enclose copies of references.—Address, 4478, The Engineer Office. 4478 A

CIVIL ENGINEER, with Special Knowledge of Brick Buildings, WANTED for first-class English Contracting Firm in India. Excellent prospects. Public school man preferred. Aged 30. Five years' agreement. Previous Indian experience an advantage.—Write, with copies of testimonials and photograph, if possible, to Box Z. T. 420, care of Deacon's Advertising Agency, Penchurch-avenue, E.C. 3. 4495 A

CHIEF OF PLANNING AND PROGRESS DEPARTMENT. A VACANCY in a medium-size Engineering Works, manufacturing complicated machinery on repetition lines.—Address, giving full particulars of experience, age, and salary required, 4473, The Engineer Office. 4473 A

CONSTRUCTIONAL STEEL WORK DESIGNER REQUIRED for London Consulting Engineer's Office. Must be conversant with requirements of 1909 Building Act. State experience and salary expected.—Address, P2630, The Engineer Office. P2630 A

ENGINEER.—WANTED, YOUNG MAN, with sound and wide education and suitable training for maintenance of up-to-date power and manufacturing plant.—Write, "G. P.," c/o 6, Bloomsbury-street, W.C. 1. P6245 A

SITUATIONS OPEN (continued)

PATENT AGENTS' ASSISTANT WANTED for American Firm.—Address, stating age, salary required, and experience, 4480, The Engineer Office. 4480 A

SALES MANAGER, Fully Qualified, REQUIRED IMMEDIATELY by PETTERS LIMITED for their Ipswich Works, with first-class experience in the marketing at home and abroad of Internal Combustion Engines for industrial, electrical and marine purposes.—Write in confidence, giving full particulars of career to date and stating salary required, to Mr. H. S. ASPINALL, Redcote, Ipswich. 4474 A

STRUCTURAL STEEL WORK.—REQUIRED, CHIEF ASSISTANT in Small Drawing-office, capable designer and efficient detailer, able to take site measurements and thoroughly acquainted with building trade requirements. State full particulars in confidence.—Address, 4457, The Engineer Office. 4457 A

TRADE MARKS.—WANTED, Well-educated Experienced MANAGER for Trade Marks Bureau. State age, experience, salary required.—Address, 4481, The Engineer Office. 4481 A

WANTED AT ONCE, STRUCTURAL STEEL WORK DRAUGHTSMAN, capable of Surveying Sites and Taking Charge of Contracts. Must be conversant with the requirements of the L.C.C. Steel Frame Acts.—Address, stating age, qualifications, experience, and salary required, 4458, The Engineer Office. 4458 A

WANTED, DESIGNER, Technical Knowledge, experience High-speed Diesel Engines. Speed, accuracy, skill in scheming essential. Experience Aero-engines desirable.—Address, stating age, experience, salary expected, 4485, The Engineer Office. 4485 A

WANTED for Works in Sumatra, Young but Experienced DRAUGHTSMAN, familiar with design and construction of Structural Steel Work; knowledge machine design preferable, but not essential.—Write, giving full particulars and salary expected, to Box 152, c/o Judd's, 47, Gresham-street, E.C. 2. 4442 A

APPLICATIONS are INVITED from DRAUGHTSMEN, not over 35 years of age, for Factory Construction and Equipment Work in North London. Good technical qualifications. Outline experience in chronological order, giving general education, including any knowledge of languages, technical training and detailed practical and drafting experience. State age, whether married, and commencing salary, and enclose copies of references.—Address, 4503, The Engineer Office. 4503 A

CONSTRUCTIONAL DRAUGHTSMAN REQUIRED in Midlands, thoroughly competent and with sound theoretical knowledge and practical experience in Colliery, Steel Works, Bridge and General Constructional Work. State age, experience, and salary required.—Address, 4483, The Engineer Office. 4483 A

DRAUGHTSMEN.—DRAUGHTSMEN REQUIRED, preferably those experienced in Automobile Body, Ship and Hull, Jigs and Fixtures, and Dies Design.—Address, 4396, The Engineer Office. 4396 A

DRAUGHTSMAN, Senior (Temporary) REQUIRED, with general engineering experience. State training, experience, age, and salary required.—Address, 4464, The Engineer Office. 4464 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine Design and Detail Work, for works in Midlands. State age, salary, experience, and when able to commence.—Address, 4366, The Engineer Office. 4366 A

FIRST-CLASS DRAUGHTSMAN REQUIRED for Way and Works Department of South American Railway. Salary according to experience. Aged 24/30.—Write, giving full particulars education, training, experience, age, with copies (only) of testimonials, to Box A. N., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 4440 A

FIRST-CLASS DRAUGHTSMAN REQUIRED for Temporary Work in Kent, experienced in Lay-out and Details of Heavy Cement Works Plant. State age and salary.—Address, 4454, The Engineer Office. 4454 A

JIG AND TOOL DRAUGHTSMEN.—TWO or THREE First-class MEN REQUIRED for Works in Surrey district. Those with experience in designing Tools for making Intricate Machinery.—Address, stating age, experience, and salary required, 4375, The Engineer Office. 4375 A

JUNIOR DRAUGHTSMAN WANTED for General work in factory in S.W. London. State age, full particulars of experience and salary required.—Address, P2642, The Engineer Office. P2642 A

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SITUATIONS WANTED

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Firms having vacancies are requested to send particulars of their requirements to the COMPANY at King's Dock Works, Swansea. 4435

ADVERTISER (L.R.I.B.A., &c.) SEEKS APPOINTMENT. Surveys, levels, plans, specifications, quantities, supervision, accounts, estate development, &c. Salary or commission.—"G.," Seven, Marston-road, Hoddesdon, Herts. P2529 B

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MESSRS. S. DORABJEE and CO., Engineering Department, Teheran (Persia), will be pleased to RECEIVE CATALOGUES, PUBLICATIONS, AVAILABLE EXPORT PRICE LISTS, &c., of Manufactures in all Branches of Engineering. P2584 I

For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Railway Electrification in Spain.

AN interesting and important scheme of railway electrification work is behind the order which the Metropolitan-Vickers Electrical Company has just received from Spain for one hundred and four 230 H.P. motors for motor coaches. The scheme covers the electrification of two main line sections of the Norte Railway near Barcelona. The first sections to be electrified are from Barcelona to Manresa, a distance of 64 kiloms., and from Barcelona to San Juan de las Abadesa, a distance of 106 kiloms. The system adopted is 1500-volt direct current, with overhead conductor. Power will be bought from a hydro-electric plant and will be transformed in rotary converter sub-stations. The passenger stock arranged for comprises twenty-six train units, each unit consisting of one motor coach and one trailer coach and providing seating accommodation for about 200 people. The mechanical parts for the coaches will be manufactured by the Sociedad Española de Construcción Naval, which is associated with the Metropolitan-Vickers Electrical Company, at its Bilbao works. Each motor coach will be equipped with four 230 H.P. motors of the Metropolitan-Vickers self-ventilated series-wound type, each pair of motors being connected permanently in series to the 1500-volt supply. The field system of the motors is arranged for weak-field control, in order to give additional economical running notches on the controller. The trains will operate at an average schedule speed of 32 miles per hour and will be capable of a maximum speed of 56 miles per hour.

American Navy Estimates.

ON Saturday last, January 8th, after a prolonged and heated debate, the U.S. Naval Supply Bill for the coming fiscal year was passed by the Lower House of Congress. The amount voted is £64,800,000. No provision is made for new warships, but a credit of £40,000 is set aside as a first instalment for the building of a rigid airship to replace the lost Shenandoah. Early in the debate it seemed certain that the Bill would be amended to include a vote for the immediate construction of three 10,000-ton cruisers, representing the residue of the programme of eight cruisers which was authorised in December, 1924, five of which have been already laid down or ordered. It was further anticipated that the Bill introduced last month by Mr. Butler, Chairman of the Lower House Naval Committee, providing for an additional ten cruisers, would be passed, in view of the strong support it had received from Congress as a whole. For some weeks previously a vigorous agitation in favour of the Bill had been conducted by the "big-Navy" group, on the grounds that the United States was hoodwinked at the Washington Conference and that the Limitation Treaty had been invalidated by the action of other Powers, notably Great Britain and Japan, in starting a new "naval race." These and other wild charges were repeated in the course of Saturday's debate, but finally the scale was turned by an eloquent speech from Mr. Theodore Burton, who pointed out the inconsistency of which the American nation would be guilty if it began to expand its navy while preaching disarmament to other peoples. It is now highly improbable that any further ships will be laid down for the United States Navy during the present year.

Railway Rates and Charges.

UNDER Sec. 30 of the Railways Act, 1921, the railway companies were to submit a schedule of the standard charges they proposed to make, and, under Sec. 31, the Railway Rates Tribunal was to consider the schedule, and any objections thereto, and "settle the schedule of charges and appoint a day—hereinafter called the 'appointed day'—when the same shall come into operation." The proposed schedules were duly submitted by July, 1923, and led to 600 objections being lodged. These were heard on fifty-five days between April 13th and October 12th last. Under Sec. 58 the charges are to be such as will yield an annual net revenue equivalent to that of the year 1913, together with certain small amounts. It was subsequently agreed that the sum to be provided for was £195,652,983, allocated thus:—London and North-Eastern, £61,038,766; London, Midland and Scottish, £79,457,643; Great Western, £31,965,893; Southern, £23,170,621. On Friday of last week, January 7th, the judgment of the Tribunal was issued. The new freight rates are generally based on an increase of 50 per cent. above 1913 level to 60 per cent., so as to bring in 6 per cent. more than now. These proposals are practically accepted. The suggested workmen's fares are to be modified; some low fares are to be higher and some high fares reduced. As there is less need in these days of better telegraphic and telephonic communication, for traders and their representatives to travel, traders tickets are to be 25 per cent. instead of 42½ per cent. lower than the corresponding season tickets. The proposals of the Southern Railway as to no reduction being made in cases in which privately owned wagons are provided, are to be limited to the Kent coalfield. The "appointed day" has yet to be fixed, but, in our opinion, there is nothing to prevent the railway companies forthwith taking advantage of the House of Lords judgment mentioned in our Railway Matters column on December 24th, and raising some of their rates now.

The French Navy.

THE French Chamber of Deputies will be asked shortly to vote the credits necessary for the construction of vessels during the year beginning July 31st next, and to authorise new regulations for increasing the number of officers and men, and offering advantages which will keep officers in the service and facilitate the re-engagement of men. Now that the French Navy is being reconstituted with ships of entirely new types, something, it is felt, must be done to form the *personnel* which has been neglected during the past decade, when practically nothing could be done for the navy. Through lack of encouragement, officers resigned, and as the naval conscription is likely to be affected by the short-term service in the army, it is desirable to offer inducements for re-engagements. In a word, the navy must present attractions as a career. This re-organisation has become urgent in view of the progress that has been made with the carrying through of the programme of naval construction. There has been some delay, but, nevertheless, in addition to the vessels that were put into service during the past year, there are under construction seven cruisers, twelve destroyers, twenty torpedo boats and fifty submarines. The last naval law authorised the construction of another cruiser, three destroyers, four torpedo boats, seven submarines, a submarine parent ship, two oil tankers, and a training ship. A hundred million francs were also voted for naval aviation. There has been some criticism over the character of the programme, which excludes battleships, but it is perfectly understood that when a navy has to be entirely reconstituted, under conditions that necessitate an economy of expenditure, it is desirable to begin with the construction of cruisers and light craft which are regarded as necessary for the special requirements of national defence.

Bradford Electricity Supply.

THE very important decision to extend the capacity of the Valley-road Power Station of the Bradford Corporation by the addition of an exceptionally high-pressure steam plant has been reached, on the recommendation of Mr. Thomas Roles, the city electrical engineer, and the contract for the work has been placed with the English Electric Company. The new plant will consist of a Babcock and Wilcox boiler, designed for a gauge pressure of 1100 lb. per square inch, and capable of evaporating between 75,000 lb. and 94,000 lb. of water per hour, the steam temperature being 800 deg. Fah. This boiler will be equipped with divided chain grate stoker gear and compartmental balanced draught, and provision will be made in the combustion chamber design to permit of the use of pulverised fuel if it should be deemed desirable. An air preheater, as well as an economiser, are to be fitted. The high-pressure steam, 1000 lb. at the turbine stop valves, will drive a 2500-kilowatt back pressure turbine which will exhaust into the existing steam mains at 210 lb. It will be a plain impulse machine running at a high speed and driving the generator at a 1000 r.p.m. through reducing gearing. At the same time the installation of a 25,000-kilowatt alternator for normal pressure has been sanctioned, thus bringing up the total power of the station from 64,000 to 91,500 kilowatts. It is expected that the high-pressure plant will be completed by about March, 1928.

The Rating of Machinery.

UNDER the chairmanship of Mr. Edward Shortt, K.C., a Committee was some time ago appointed by the Minister of Health to advise him what machinery and plant should be held to fall within the classes specified, in the Rating and Valuation Act, 1925, for inclusion in local rating assessments. The Committee has now issued its report. It is not unanimous and, as a consequence, some people are wondering whether it is reasonable to expect uniformity of treatment among the 2113 authorities affected by the Act if the Committee itself is unable to agree regarding what machinery is to be rated and what is not. The Committee's report provides for many classes of machinery to be included in future valuations, which it was widely assumed would be excluded. For example, the third schedule to the Act states that lifts and elevators mainly or usually used for passengers are to be rated. From this statement it was generally inferred that lifts and elevators used for goods would not be included in the valuation. The Committee's report, however, is worded to include among plant which may be rated practically all forms of lifts and elevators. In dealing with what the Act describes as "such" part of any plant . . . as is, or is in the nature of, a building or structure," the Committee's report is worded to include the whole instead of a part of the plant. In the opinion of some there is no limit to the classes of machinery and plant which may be brought into the valuation on the ground that they are "in the nature of a structure," and it is feared that if the report is adopted as it stands, manufacturers will lose much of the relief which it was the intention of the Act to give. Objections to the report may be lodged with the Minister of Health up to the 30th of this month.

The Electromobile Association.

WE are informed that Lord Montagu of Beaulieu has consented to act as the first President of the Electromobile Association. That body was formed in July last year, and is designed to promote the study and development of electrically-propelled vehicles, tractors and vessels. It is evident that the name electromobile as used by the Association is not intended to be restricted to the hitherto usual application signifying in effect an automobile propelled by means of electric storage batteries. The term is defined in the articles of association as meaning "any type of road, railway, marine, mining, dockyard, factory, warehouse, mobile or vehicle, tractor or vessel in which electricity plays some part in the actual propulsion." This definition clearly embraces electric railway locomotives and electrically-propelled ships, as well as the electrically-driven road vehicle. There is, however, considerable evidence that the electrically-driven road vehicle is to be accorded a large if not the main portion of the association's attention. The offices of the new body are at 3/7, Southampton-street, W.C. 2.

Mr. Alexander Galbraith.

MR. ALEXANDER GALBRAITH, who recently took up his new duties as general manager of the Dalmuir Yard of William Beardmore and Co., Ltd., in succession to Mr. A. G. Campbell, has occupied responsible positions with the firm for a number of years. He is a native of Stranraer, and after receiving his early education at the Stranraer Academy, he underwent training as a marine engineer in the works of Laird Brothers—now Cammell Laird and Co., Ltd.—at Birkenhead. After leaving Birkenhead he was appointed an assistant to Professor Stanfield in the Department of Mechanical Engineering at the Heriot-Watt College, Edinburgh. From Edinburgh Mr. Galbraith passed to Glasgow, where he became personal assistant to Dr. H. F. Stockdale, of the Royal Technical College, in which capacity he did good work in organising continuation classes in science for Glasgow and the West of Scotland. He left Glasgow to accept an appointment as assistant superintendent engineer to the Cunard Line at Liverpool, and later on became the superintendent engineer of the Cunard Company, a position which he held for seven years. During the war period, besides fitting out a number of the company's ships as armed vessels, Mr. Galbraith was responsible for the work of the Cunard National Shell Factory. He left Liverpool to become general manager of the Dalmuir Ordnance Works of William Beardmore and Co., Ltd., and when at the close of the war that department was converted for the manufacture of locomotives, he became departmental manager. Later he was appointed general engineering manager for the whole yard and then deputy general manager, becoming general manager at the beginning of this year.

Shipbuilding in Germany.

RECENT reports from Germany foreshadow a better outlook in the shipbuilding industry of that country. At the end of 1925 orders in hand only amounted to some 235,000 gross tons, or less than one-fifth of the corresponding pre-war figure for German firms. By the end of last year the orders on hand had nearly doubled in tonnage compared with the previous year, and with the recent orders for motor ships for the Hamburg-American Line and the North German Lloyd Company, there is the prospect of a distinct improvement in industrial conditions. Just before the close of last year a new shipbuilding group was formed, known as the Deutsche Schiffs und Maschinenbau A.G., in which has been included the amalgamated interests of several important Hamburg and Bremen shipbuilding firms. The new combine is stated to have received the order for one of the two new North German Lloyd passenger liners of 46,000 tons, and, in addition, the group has orders on hand for thirteen ships representing a total of some 150,000 gross tons. The other North German Lloyd liner has been placed with Blohm and Voss, of Hamburg, which firm is also constructing a new Swedish-American motor liner and three other ships, which brings its total tonnage to be constructed to about 123,500 gross tons. Considerable interest has been shown in the renewed rivalry between the Hamburg-American Line and the North German Lloyd Company in the matter of large passenger liners, and it seems to be not unlikely that the first named company will now consider the placing of orders for larger Atlantic liners.

Aeronautics in 1926.

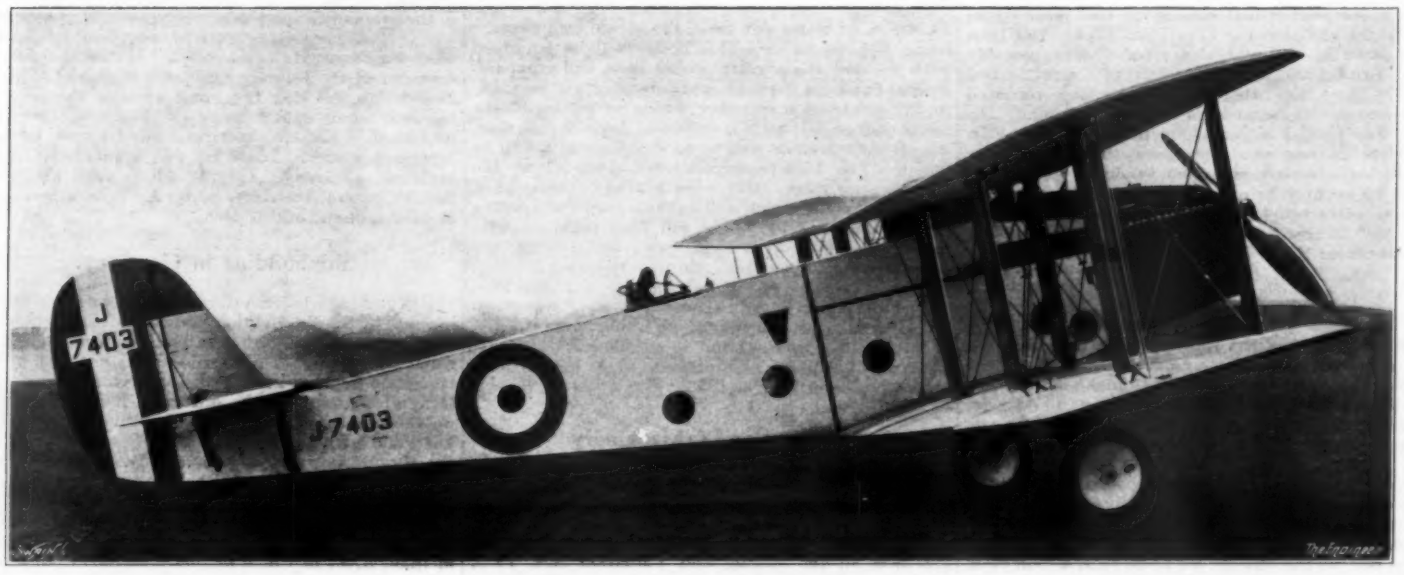
No. II.*

WE continue below our summary of the principal work—so far as it may be disclosed—undertaken by British aeronautical manufacturers during the past year.

The Bristol Aeroplane Company, Ltd.—In addition to the production of aircraft of many types for the Air Ministry, the Filton works of the Bristol Aeroplane Company, Ltd., were kept steadily employed during the year on the manufacture of aeroplanes for foreign countries, including Chile, Hungary, and Bulgaria. Several new types of machines were produced. Certain of these machines were of all-metal construction, a development which the company has fostered for some time and for which it has made provision by the equipment of some large shops with the necessary specialised machinery. The machines turned out during the year ranged from 800 lb. to 8000 lb. in weight. Of the more interesting designs it is, however, permissible to deal only with three. The Bristol "Boarhound," illustrated herewith, is a two-seater fighting, reconnaissance or day-bombing machine, of which the structure, except the fabric covering, is entirely of metal. The general design typifies the principles of metal construction evolved by the company. Particular attention has been paid to eliminating the possibility of failure as a result of fatigue or corrosion and, by the reduction of the number of riveted joints, to the facility with which repairs and replacements may be made. The view afforded the pilot forwards and downwards is made to cover a wide range by the adoption of a sloping cowling to the engine end, of a thin wing section, of a cut-away in the top centre plane, of a small chord, and of a staggered bottom wing. The gunner's cockpit is so placed relatively to the bottom wing that he can fire vertically downwards over the side of the fuselage. Dual control is provided. All the control surfaces are balanced and the ailerons are of the patented Bristol Frise type, which, it is claimed, produce a very small yawing effect and ensure adequate control at the stalling speed.

The military equipment, for the carriage of which provision is made, consists of a Vickers gun in the pilot's cockpit, a Lewis gun on a Scarff ring mounting in the gunner's cockpit, bombs, wireless apparatus, camera, oxygen and signalling apparatus. The fuel is carried in two tanks, each holding 28 gallons, fitted in the wings and in a 46-gallon tank on top of the fuselage. A 9-gallon oil tank is also arranged on top of the fuselage. An oil cooler is fitted below the fuselage and is provided with an automatic by-pass for regulating the oil temperature. The engine is a Bristol "Jupiter" Series VI. and is provided with an exhaust ring and tail pipes to conduct the gases beyond the cockpits and to hide the flame during night flying. The machine has a span of 44ft. 9in. and a wing area of 464 square feet. Its total weight is 3994 lb., of which 656 lb. represents the fuel and oil, 360 lb. the crew, and 448 lb. the military equipment. It has a maximum speed of 132 m.p.h. and a minimum speed of 52 m.p.h. It can climb to 5000ft. in 4·8 minutes and to 15,000ft. in 18·8 minutes. Its service ceiling is 21,800ft. and its absolute ceiling 23,600ft. The second Bristol machine with which we may deal is also a military one. It is known as the "Berkeley" bomber and is illustrated herewith. The construction is again carried out in metal. The engine is a Rolls-Royce "Condor" of 660 normal horse-power and 720 maximum horse-power. The pilot is seated ahead of the wings and is afforded a good view forwards and downwards. In addition, as his eyes are level with the top wing, he can also see backwards above and below that wing. The gunner is stationed well to the rear of the wings and has a good field of fire above and below the tail as well as downwards. Under each wing bomb racks are placed to carry either one 520 lb., two 230 lb., or four 112 lb. bombs. Four 20 lb. sighter bombs are carried under the fuselage. All the racks are provided with quick-release pins. The bombs can be released from three positions and the releasing and fusing gear is operated by means of tubes and bell cranks and not by cables, which are liable to stretch and cause jambing. The bomber's observation aperture provides a good view forward and backward and also sideways. It can be closed by a shutter, which is bolted from the inside. Windows and swinging electric lights are arranged to illuminate the bomb sight and other instruments. The rudder control operated by the bomber can be automatically disconnected by the pilot at any time when he finds it necessary to take charge of the course of the machine. The machine is equipped to carry a camera and with long-wave, short-wave and direction-finding wireless. All the wireless sets are mounted on quickly detachable panels. The engine is carried on a rigid mounting, which enables all adjustments to be made without removing the engine. The radiator is mounted on rubber baffles and is easily detached. It is arranged that the radiator shutters shall close more slowly towards the end of their range than at the beginning in order to increase the fineness of the temperature control. A water header tank holding 4 gallons and fitted with baffles and a steam separator is fixed between the engine cylinders. A gas starter for the engine is mounted in the passage-way between the cockpits. The petrol is carried in a gravity tank under the top centre section and in two main tanks in the fuselage. The overflow from the gravity tank is returned to the main tanks through a flow indicator. The aileron control is of the Bristol patented type already mentioned. It is claimed that, at bombing speeds, the operation of the ailerons has no effect on

BRISTOL "BOARHOUND" TWO-SEATER MILITARY MACHINE



BRISTOL "BERKELEY" DAY BOMBER

* No. I. appeared January 7th.

the rudder control and does not therefore affect the rudder movements made by the bomber. The machine has a span of 57ft. 11in., an overall length of 47ft. 6in., and a wing area of 989 square feet. It is equipped to carry 235 gallons of petrol and 19 gallons of oil, or sufficient for 5¼ hours' flying at normal power. Its total loaded weight is 7935 lb., of which 1815 lb. represent the fuel, oil and water and 1260 lb. the crew and military load. Carrying these weights, the machine is officially recorded to have a speed of 118 m.p.h. at ground level and 100 m.p.h. at 10,000ft. It can climb to 10,000ft. in 13¼ minutes and to 16,800ft. —its service ceiling—in 35 minutes. The performance of the machine is guaranteed to within 10 per cent. of these figures.

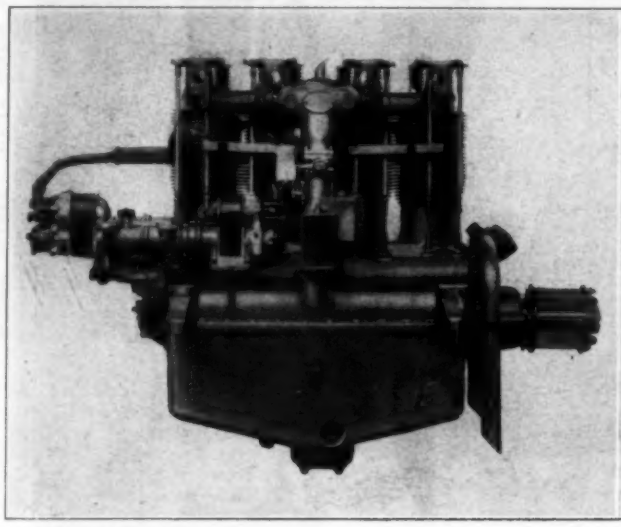
The third Bristol machine with which we will deal is the "Badminton," a single- seater, primarily intended for cross-country racing and exhibition flying. This machine, illustrated on page 36, is driven by a Series VI. "Jupiter" engine fitted with variable timing gear and cowled, to reduce drag, in sheet duralumin. The fireproof bulkhead in rear of the engine consists of asbestos sheet sandwiched between sheets of aluminium. The fuselage frame is built up of silver spruce struts braced by steel tie rods and is covered for the most part with three-ply wood. The wing structure is carried out in silver spruce for the spars, ribs and leading edge, the trailing edge and the internal struts being of steel tube and the internal cross bracing of steel tie rods. Ailerons are provided on the bottom wings only. The interplane struts are of silver spruce and end in nozzles which are threaded right hand at the top end of the struts and left hand at the bottom end. The struts in this way are made to serve as turn-buckles to facilitate the adjustment of the incidence and gap of the wings. The fuel is carried in three tanks, namely, a 15-gallon gravity tank on top of the fuselage, a 35-gallon main tank inside the forward end of the fuselage, and a 10-gallon tank mounted on the port side of the fuselage beside the main tank. The main and side tanks are equipped with air pressure feed, although except during climbing their position is such that they can feed the carburetter by gravity unaided. The oil tank, holding 7 gallons, is mounted on the starboard side of the fuselage opposite the side petrol tank. An oil cooler is incorporated in this tank. A second oil cooler is arranged to form the leading edge of the bottom centre section of the wings. The machine has a total wing surface of 210 square feet, and with pilot and fuel weighs 2460 lb. Details as to its speed, &c., have not been furnished us.

On the engine side the Bristol Company continued to achieve great success with its "Jupiter," "Lucifer," and "Cherub" engines. The "Jupiter" engine is now made in three standard types. The high compression service type has a compression ratio of 6·3 to 1 and develops 470 B.H.P. at 1700 r.p.m. at ground level. This type is particularly intended for machines normally operating at altitudes of 15,000ft. and upwards. The standard service engine of 5·3 to 1 compression ratio develops 450 B.H.P. at 1700 r.p.m. at ground level and is intended for machines normally operating at medium altitudes and requiring the development of maximum power at ground level. The standard commercial type has a compression ratio of 5 to 1 and develops 420 B.H.P. at 1700 r.p.m. at ground level. It is particularly intended for commercial machines. Its relatively low rating ensures increased life between overhauls and good running under varying conditions.

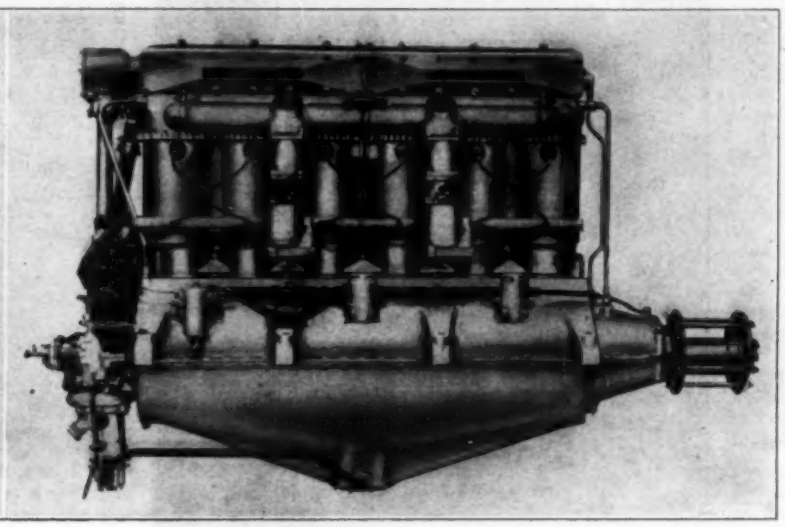
A.D.C. Aircraft, Ltd.—The company, formerly known as the Aircraft Disposal Company, which, under Mr. Handley Page's directorship, was formed soon after the war to take over and dispose of the Government's surplus stocks of aeroplanes and aero-engines, is now known as A.D.C. Aircraft, Ltd., and at its works at Croydon is undertaking the manufacture of new designs of aero-engines as a part of its activities. During the past year the Cirrus engine, a low power unit produced some time ago for use in light aeroplanes, was designed and manufactured in a new form. The original design, which is not intended to be superseded by the new Mark II. type, develops a normal 60 h.p. at 1800 r.p.m., and a maximum of 65 h.p. at 2000 r.p.m. The new design was produced to meet a demand for increased speed or increased lift in light aeroplanes or for a low-powered engine to be used in light seaplanes. It develops 75 h.p. at the normal speed of 1800 r.p.m., and 80 h.p. at 2000 r.p.m. Yet in spite of this substantial increase in power, the weight of the engine is actually 8 lb. less than that of the Mark I. series, while its petrol consumption is 0·57 pint per horse-power hour, as compared with the 0·66 pint of the earlier production. The features of the new type—of which a photograph is reproduced herewith—include the installation of a dual type of carburetter fitted with an altitude control, the use of a special impulse starting magneto, which makes it possible to start the engine with a very light pull on the propeller, the employment of connecting-rods of stamped duralumin, and the heating of the induction system by the exhaust. On test the engine has given 88 h.p. at 2200 r.p.m. Cirrus engines have found particular application in de Havilland "Moth" light aeroplanes. We are informed that with a Cirrus engine a "Moth" can fly approximately 20 miles to the gallon, and that over a period of eighteen months the average cost of replacement parts for the engine is under ¼d. per mile. These figures compare very favourably with the corresponding figures for a motor car. During the year the company produced another new type of engine, known as the "Nimbus." This engine, illustrated herewith, was designed to fill a hitherto unsupplied need, namely, that for a six-cylinder water-cooled engine of medium power with its cylinders arranged in line. The Nimbus resembles outwardly the Siddeley "Puma" engine, but in its characteristics and in the details of its design, it is essentially different. Its normal output is 300 h.p., as compared with the 240 h.p. of the "Puma," while its weight is actually 10 lb. less, and is only 2 lb. per horse-power, as compared with the 2·66 lb. of the other engine. During the Air Ministry type, test the engine, running at 1450 r.p.m. and developing nine-tenths of its normal power—*i.e.*, 270 h.p.—consumed 0·505 pint—0·474 lb.—of petrol and 0·017 pint—0·019 lb.—of oil per horse-power hour. Subsequently, the engine was run up to 1600 r.p.m., and at that speed developed 335·6 B.H.P. It is claimed that the "Nimbus" engine gives a light-weight power unit of a simple and trustworthy design without resort to gear reduction and without an unduly high airscrew speed. From the constructional point of view, it may be noted that the water jackets are two aluminium castings, each of which encloses three cylinders. The cylinder heads are bolted to the tops of the water jacket castings, and from them steel cylinder liners extend downwards to glands at the foot of the jacket castings. One inlet and two exhaust valves serve each cylinder. The pistons are of aluminium alloy. There are two carburetters, each of which feeds three cylinders.

The Fairey Aviation Company, Ltd.—We generally look to the Fairey Aviation Company, Ltd., of Hayes, Middlesex, to supply us with some particularly interesting news concerning aeronautical developments. A year ago, for example, we were enabled to publish some early information regarding the remarkable Fairey "Fox" two-seater day bomber. This year, however, strict secrecy surrounds all the new designs produced by the firm during the past twelve months. The "Fox" is now being supplied in quantities to the Royal Air Force, while two other types of Fairey machine, which we described and illustrated in past reviews, namely, the "Fawn," a three-seater Army reconnaissance machine convertible into a day bomber, and the "Flycatcher," a single-seater deck-landing machine which is also employed as an amphibian, are now in extensive use in the Force. Another design of Fairey machine, that known as the III. D type, maintained its prominence during the year. It was on four machines of this design that Wing Commander Pulford and his seven companions carried out their remarkable flight from Cairo to the Cape and back again to Cairo, and then on to England. For the stage from Cairo to England, the machines were deprived of the land carriages with which so far they had been equipped, and in their place were fitted as seaplanes with floats. The whole trip was performed to schedule, without mishap or incident. The firm continued to develop and employ all-metal propellers, of which it manufactures the Fairey-Reed type.

A. V. Roe and Co., Ltd.—Concerning the work of A. V. Roe and Co., Ltd., of Manchester and Southampton, we can say very little, for most of it was carried out on behalf of the Air Ministry. Of one of the military machines produced we give an external view herewith. This machine, known as "The Avenger," is a single-seater fighting scout, and is equipped with a Napier Lion Series 8 direct-drive engine. Attention may be directed to the extent to which the stream lining of all the surfaces contributing resistance has been carried. Even the engine is completely enclosed in a stream-lined cowling, and the propeller boss forms a natural continuation of the stream line fuselage. The radiator evicted from its normal position by reason of the cowling of the engine, is placed, in two sections, on the underside of the upper wings. A recess for a gun, firing through the propeller, may be noted on the side of the fuselage. The firm continued to develop the light aeroplane, and produced a two-seater design of this class, known as the "Avian." The wings of this machine are arranged to fold to a maximum width of 9ft. 6in. The construction is straightforward and orthodox, everything possible being done to cheapen and facilitate production.



"CIRRUS" MARK II. 75/80 H.P. ENGINE



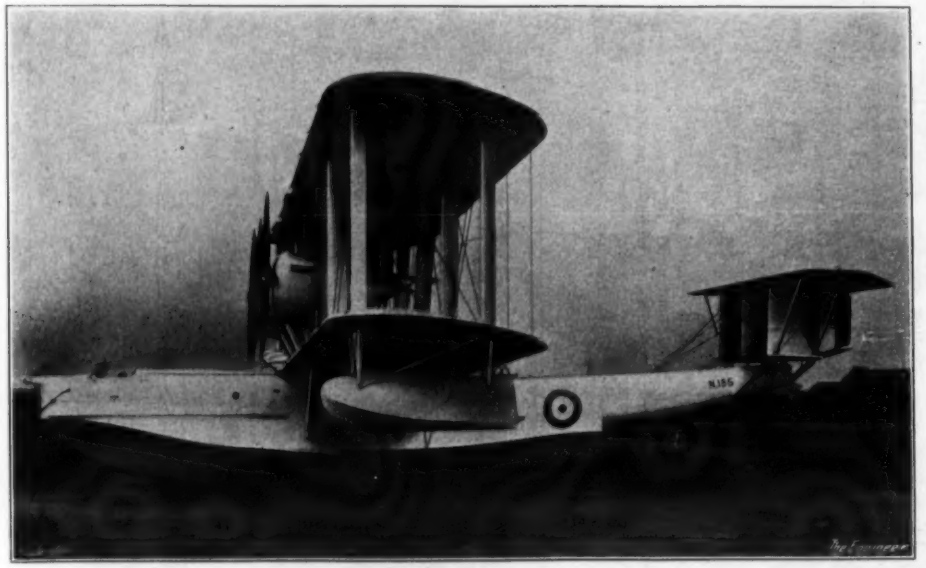
"NIMBUS" 300/330 H.P. SIX-CYLINDER ENGINE

AVRO "AVENGER" SINGLE-SEATER SCOUT

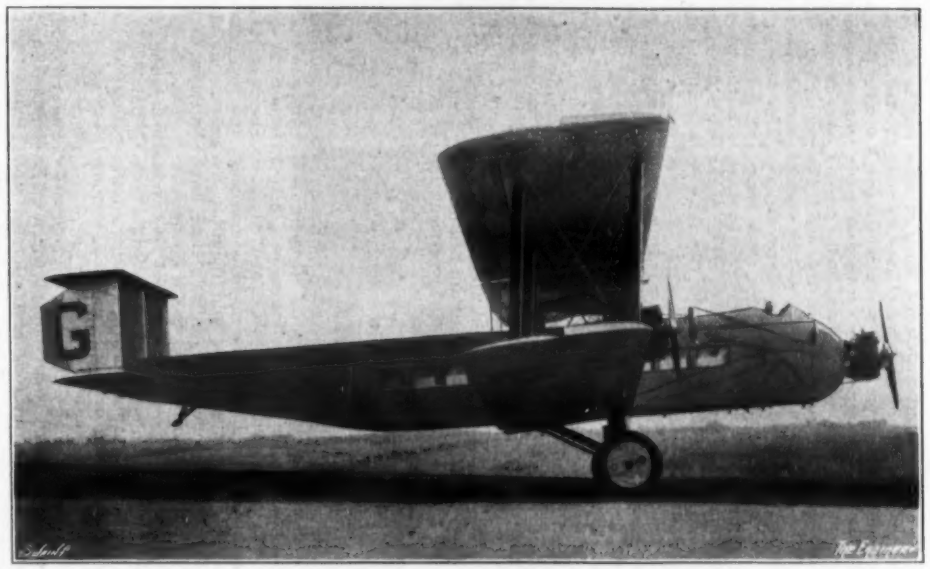
Boulton and Paul, Ltd.—Little can be said regarding the work done at the Norwich establishment of Boulton and Paul, Ltd. In our issue of March 12th, 1926,

SOME AEROPLANES OF 1926

BRISTOL "BADMINTON" SINGLE-SEATER RACING MACHINE



BLACKBURN THREE-ENGINED "IRIS" FLYING BOAT

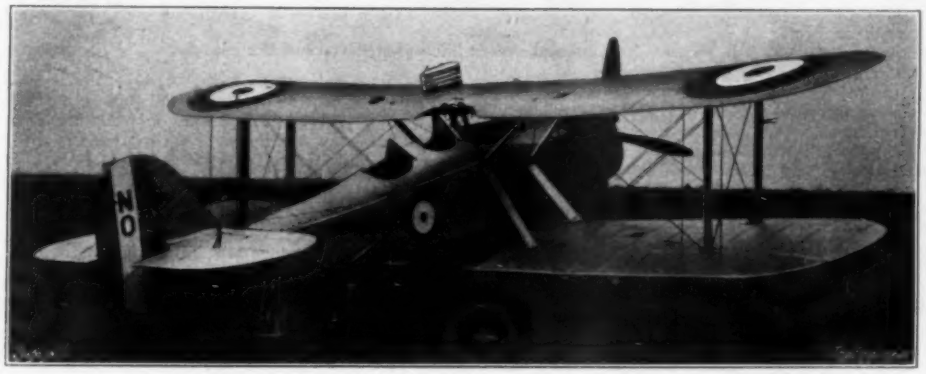


ARMSTRONG-WHITWORTH "ARGOSY" TWENTY-SEATER THREE-ENGINED AIR LINER

GLOSTER "GAMBET" SINGLE-SEATER DECK-LANDING SCOUT

we published some particulars describing the progress being made by the firm in connection with its metal construction system. The policy of standardisation therein mentioned has been steadily developed, and much valuable information has, we understand, been accumulated. The firm has applied modern aerofoil theory to the development of new aerofoil sections, with considerable success. Similar principles have been applied to the design of body forms. It is probable that more will be heard during the course of this year concerning these developments. The firm was busily engaged during 1926 on machines constructed to Air Ministry contracts, but concerning them nothing may yet be published. An interesting development of the company's extensive experience with metal construction for aeroplanes is the fact that it was chosen to manufacture the metal structure of his Majesty's airship R 101, now being built at Cardington. We learn in this connection that the firm's methods have resulted in a considerable economy of structural weight, as compared with types of airship construction previously adopted.

The Blackburn Aeroplane and Motor Company, Ltd.—Three new designs of machines were produced during the year by the Blackburn Aeroplane and Motor Company, Ltd., of Leeds. Concerning one, the "Ripon," we are not permitted to say more than that it is a torpedo plane developed from the firm's "Dart" machine, which we have illustrated on former occasions. The "Sprat," the second of the firm's new designs, is an "all-purpose" training machine, which may be fitted interchangeably with a land or a float chassis. We illustrate it herewith in its land form. It is a two-seater machine driven by a 275 h.p. Rolls-Royce Falcon engine. The top and bottom wings are of equal span and chord and are arranged to fold for storage purposes. A feature of the chassis is the wide distance between the wheels or floats, and the fact that each wheel or each float may be dismantled or applied separately. There is no cross-axle between the wheels or floats, a fact which should render the machine unlikely to turn over on its nose if it should have to land in tall grass or corn. The pupil sits in a cockpit in line with the rear edge of the upper wing, and the instructor is accommodated in a cockpit still further aft. From both cockpits the view obtained is good; sufficiently good, in fact, to make the machine suitable for deck landing. The flying instruments are carried on the rear spar of the upper wing, just in line with the pupil's eyes and also visible by the instructor in the after cockpit. As a land plane the machine has a top speed at all heights up to 5000ft. of 100 knots, and can climb to 1100ft. in one minute. The landing speed is 39 knots, and the service ceiling 17,500ft. The company's third design produced during the year was the "Iris" triple-engined reconnaissance flying boat, of which we give an illustration on page 36. This machine has top and bottom wings of equal span and chord, and is provided with a biplane tail carrying three fins and three rudders. The original hull designed for the machine is of wooden construction, and accommodates a crew, under normal conditions, of five. The accommodation and the facilities for intercommunication have been particularly studied, and the defensive armament provided is stated to render the machine practically invulnerable. A second hull of similar design, but of all-metal construction, is now being built. The engines are three Rolls-Royce "Condors," of 650 horse-power each. Nothing may be said regarding the speed and other features of the performance of the machine. During the summer months, however, it was publicly demonstrated that it could fly on a level course or climb or be manœuvred with any one of the three engines shut down, and even be turned to starboard with the port engine out of action. With only the central engine running, the machine flew with a loss of height that could not be detected without the aid of instruments.



BLACKBURN "SPRAT" TWO-SEATER TRAINING MACHINE

Sir W. G. Armstrong, Whitworth Aircraft, Ltd.—At the Coventry aircraft works of the Armstrong, Whitworth Company, steel construction continued to be developed during the year. On the military side the all-steel single-seater fighter, known as the "Siskin," originally developed some few years ago, was built in a new form—illustrated herewith—known as the Siskin III. A, the characteristic feature of which is that it is driven by a Jaguar 400 horse-power supercharged engine. The effect of using a supercharged engine is to increase the speed attained at most altitudes, at some even to make it greater than the speed at ground level. In the case of the Siskin III. A, the speed at ground level is stated to be 143 miles an hour, at 9850ft. about 153 miles an hour, and at 19,700ft. about 141. The machine can climb to the first-named height in 6·5 min., and to the second in 17 min. Its ceiling is 27,000ft. As definite particulars for the performance of aeroplanes fitted with supercharged engines are as yet scarce, we may add that a modified light type of Siskin machine, driven by a Jaguar supercharged engine, is stated to have a speed at ground level and at 19,700ft. of 155 miles an hour, while at the intermediate height of 9850ft. its speed is 168 miles an hour. On the commercial side, the firm completed and delivered to Imperial Airways, Ltd., the twenty-seater Argosy passenger liner, of which we gave a general drawing in our review a year ago. Two of these machines are now in use on the company's routes. The machine, of which a photograph is reproduced on page 36, has a cabin with a minimum head room of 6ft., which contains seating accommodation for twenty passengers. In addition, a crew of two is carried. It is driven by three Jaguar engines placed one at the nose of the fuselage and two approximately in line with the first pair of wing struts on each side of the body. With a full load and only two of the engines running, the machine will maintain a height of at least 2000ft. With very little effort on the controls it will fly straight, though not necessarily level, with only one engine in action. The fuselage is constructed of steel tubing, but the wings may be either of steel or wooden construction. The machine has a span of 90ft., a length of 64ft. 6in., and a height of 19ft. Fully loaded it weighs 18,000 lb., of which 4500 lb. represents the paying load. Its top speed is 110 miles an hour, and at the cruising speed of 95 miles an hour its endurance is four hours. The pilot's cockpit is fitted with dual control. Wireless apparatus is carried in a compartment immediately behind the cockpit. The passengers' cabin is provided with electric lighting and a ventilating and warming system. On the experimental side, the firm completed and delivered to the Royal Aircraft Establishment at Farnborough three specially designed aeroplanes for aerodynamic research. These machines are constructed in such a way that (*a*) the frame may be lengthened or shortened; (*b*) the centre of pressure may be altered; (*c*) the gap and stagger of the wings may be changed; and (*d*) three different sizes of tail plane and rudder may be fitted. The machines are intended particularly for experiments on stalled flight, and are provided with very long travels in their oleo landing gear, in order that landings may be made with the machines in the fully stalled condition. The firm is continuing to develop its system of metal construction, and is engaged on experimental work for the Air Ministry.

ARMSTRONG-WHITWORTH "SISKIN" III.A SINGLE-SEATER FIGHTER

The Gloster Aircraft Company, Ltd.—At the Cheltenham works of the Gloster Aircraft Company, Ltd., metal construction figured prominently in the year's work. Several of the company's designs originally carried out in wood, such as the "Gamecock" and the "Gorcock," both single-seater fighters, were redesigned in steel. Two new two-seater fighting machines were produced. One of them, the "Goral," is of all-steel construction. Nothing may be said about either. The "Gambet" machine, a new design produced during the year, is illustrated on page 36. This machine resembles the firm's "Gamecock," but is particularly intended for deck-landing purposes. It is a single-seater high-speed scout, and is fitted with a Bristol Jupiter Mark VI. engine of 420 horse-power. As it represents a very modern design of its class, we give below a list of its principal dimensions, &c.:—

Gloster "Gambet" Deck-landing Scout.

Wing surface	284 sq. ft.
Span—	
Top	31ft. 10in.
Bottom	26ft.
Chord—	
Top	5ft. 6½in.
Bottom	5ft. 2½in.
Gap	5ft.
Petrol capacity	72 gallons
Oil capacity	7 gallons
Duration	3¼ hours at 15,000ft. with full load
Ceiling	23,000ft.
Speed at 5,000ft.	152 m.p.h.
10,000ft.	145 ,,
15,000ft.	138 ,,
Landing speed	49 ,,
Climb to 5,000ft.	3 minutes
10,000ft.	7 ,,
15,000ft.	11 ,,
Total loaded weight	3075 lb.

The petrol is carried in two 36-gallon tanks, recessed into the top planes from which the feed is taken by gravity. The armament consists of two Vickers guns mounted at the sides of the fuselage and firing through the propeller. Provision is made for racks to carry four 20 lb. bombs. It may interest our readers to know that on the front truss of the wings the factor of safety is 7½ and on the rear truss 5. On the body, counting the landing loads, it is 6, and it is 6 also on the landing gear and tail skid. It may be remarked that in aeroplane design, factors of safety are based on the stresses imposed on the structure during *normal* flight, and not on the maximum stresses which the structure may be called upon to bear. During a loop or other manœuvre the factor of safety may be considerably less than the normal figure. The Gloster Company has for several years given close attention to the design of racing machines. The Gloster III. seaplane, which finished second in the 1925 Schneider Cup Race, was, during the past year, greatly improved. It was fitted with wing radiators and a forged propeller and generally cleaned up, and is now being used for practice purposes by racing pilots at Felixstowe. An improved, and it is hoped record-breaking, machine, the Gloster IV., is now rapidly approaching completion. An interesting item of news concerning the company is that it has acquired the world rights for the manufacture of the Hele-Shaw variable pitch propeller. This propeller is now undergoing extensive tests with, we understand, very promising results. The device is operated by means of a variable-stroke reversible oil pump, which causes the propeller blades to move in either direction. The working of the pump is controlled by a governor which is set so that the pitch of the blades is automatically varied to give a constant engine speed. A separate hand control is provided to vary the setting of the governor.

ADDITIONAL lists of articles chargeable with duty under Part 1 of the Safeguarding of Industries Act, 1921, have been issued by the Board of Trade, and will take effect as from January 15th, 1927. These lists refer to articles under the following headings:—Optical glass and optical elements; optical instruments; laboratory; porcelain; scientific instruments; synthetic organic chemicals. Copies of the lists may be obtained from his Majesty's Stationery Office, price 2d. net.

Harbours and Waterways in 1926.

THE monotonous story of absence of port development at home which has been a feature of our annual reviews of the past two or three years unfortunately has its place in any survey of dock and harbour undertakings for the year 1926. The disastrous coal strike naturally had the effect of retarding such works of extension and improvement as were in hand in the early part of the year, but quite apart from this serious but temporary set-back, there was no indication before the general strike of any marked improvement in the conditions affecting home ports. The number of Bills having reference to port works dealt with in the session 1925–26 of the Imperial Parliament showed no improvement on the business of the past few years, and in the present session the only Bill foreshadowing works of any magnitude is that of the Southern Railway Company. On the other hand, the activity in port construction and the development of inland waterways abroad, to which we called attention a year ago, is still marked, particularly in the United States of America, Canada, and in parts of South America and the Far East.

In December the International Congress of Navigation held its triennial meeting in Cairo.

The United Kingdom.

Port of London.—The Port of London Authority has at last started work upon the remodelled Tilbury extension scheme, and in July placed a contract with Sir Robert McAlpine and Sons, Ltd., for the enlargement of the Tilbury Docks, which is intended to provide facilities for the largest vessels afloat. The total cost of the new scheme will be about £2,750,000, part of which expenditure will be met by unemployment grants from H.M. Government. The work is expected to take nearly five years to complete. The new entrance to the dock will have a length of 1000ft. and a clear width of 110ft., with a depth of 45ft. 6in. over the sill at Trinity high water. A new dry dock, having an entrance from the existing wet dock, is to be built and will have a length of 750ft., capable of extension to 1000ft. when necessary. This dry dock will be 110ft. wide at the entrance, and have a depth of 37ft. 6in. over the sill. A commencement has also been made with the construction of the floating passenger landing stage and new riverside station at Tilbury. Earlier in the year the Authority placed a contract with Chas. Brand and Son, Ltd., for the construction of a new entrance to the South-West India Dock. It will have a length of 550ft. and will be 80ft. wide, with a depth of 35ft. at Trinity high water. Passages are also to be constructed to enable the largest vessels navigating up to this part of the river to proceed to any part of the India and Millwall docks system. The extensions at the Surrey Commercial Dock, covering an area of about 15 acres, were completed, and several new sheds for the timber trade, for which these extensions are intended, were brought into use during the year. At the Royal Victoria Docks the construction of reinforced concrete quays on the north side of the tidal basin and in front of the old quay wall, which was commenced in 1924, was completed. Large sheds for the accommodation of the imported meat traffic have been built behind the new wharf. The trade of the port in the last finanical year exceeded 47 million tons, an increase of nearly 2 millions over the preceding year. During the year over 4 million cubic yards of material were dredged from the river and docks, and the deepening of the Yantlet channel to 30ft. at L.W.O.S.T. was completed.

The Mersey and the Manchester Ship Canal.—The annual report of the Mersey Docks and Harbour Board for the year ended June 30th, 1926, showed a reduction in the tonnage using the port of nearly half a million tons and a corresponding reduction in the rates and dues. The Gladstone Dock extensions, begun by the Board in 1910, are still in progress, and the work of erecting sheds and cranes on the dock sides is now being proceeded with. The capital expenditure on the Gladstone Dock extensions during the past few years has averaged about one million pounds annually. The new 80ft. lock entrance at the Alfred docks, Birkenhead, as well as the 80ft. inner passage, are still under construction. Four pairs of steel gates are now being erected as part of these works. A new passage, 100ft. wide, with a depth of water of 31ft. between the West Float and Wallasey Pool, Birkenhead, is also being constructed by the Board with the view to future developments on the Cheshire side, and a new swing bridge is to be provided over the passageway.

The deepening of the Manchester Ship Canal to 30ft. between Eastham and Stanlow oil dock was completed, and quay extensions are in progress at the Ellesmere Port docks, where also coal-handling plant is being installed.

On October 23rd the new floating roadway and landing stage—see an illustration in a Supplement last week—which has been under construction at Seacombe for two years, was opened by Lord Derby. It was described under the heading of "Bridges" in last week's issue.

The building of the new Bromborough Dock on the Cheshire bank of the river Mersey for Messrs. Lever Brothers is still in hand.

Bristol Channel and South Wales Ports.—The extension of the Royal Edward Dock at Avonmouth is making good progress. The work already carried out is mainly in connection with the new reinforced concrete wharf and grain import facilities on the eastern side of the new extension. A pair of new steel gates is in course of construction for the dock entrance. The Great Western Railway Company made further progress with the remodelling and improvement of the mechanical appliances of its South Wales docks, particularly in connection with the coal hoists and hydraulic appliances. The conversion of hoists to take the new standard 20-ton wagon is proceeding rapidly. When the railway company took over the South Wales and Newport docks there were altogether about 162 coal shipping appliances in these ports, and less than twenty of them were then capable of taking 20-ton wagons. These figures serve to indicate the magnitude of the improvement upon which the company has embarked. The reconstruction of several pairs of dock gates at the Cardiff and Newport docks is also in hand, and the inverts of two locks at these ports have been reconstructed with the object of increasing the available depth by about 3ft. in each case.

Southampton.—The Southern Railway Company has once more recast its scheme for the extension of the Southampton Docks. In its latest form the scheme is estimated to cost, when completed, about thirteen million pounds, and will provide 16,600ft. of additional quayage, and accommodation for twenty of the world's largest liners. The scheme includes the reclamation of a strip of foreshore between the Royal Pier and Millbrook Point, about two miles in length and nearly half a mile wide. Parliamentary powers for that part of the scheme which is not covered by the 1924 Act are to be sought in the 1927 Session. It is proposed to dredge some of the new berths to a depth of 45ft. at L.W.O.S.T., and the construction of two large graving docks is provided for. A contract was entered into by the railway company in September for the execution of the first section of the dredging and reclamation work. The new scheme differs from that previously sanctioned in that the five long jetties projecting from the reclaimed area are abandoned, and for them a quay wall parallel to the shore and a long jetty parallel to the new quay wall are substituted. It is expected that the first section of the works, costing about three million pounds, will be completed in four years. The berth for the 60,000 tons floating dock at Southampton, which was moored there in April, 1924, has already had to be re-dredged, the dock being moved for the purpose in June. The Southampton Harbour Board during the year completed the deepening of the approach channel from Calshot to the Southampton Dock entrance to 35ft. at low water.

North-East Coast and Humber Ports.—At Newcastle the Tyne Improvement Commissioners begun the construction of a deep water quay in the river at the Albert Edward Dock. The new coal-handling plant at Sunderland is in operation, and projects for large developments on Tees-side are being actively discussed by the authorities interested.

The Castlereagh extension of the Seaham Docks and the new coal staithes which form a part of it were brought into use during the year. These staithes have been designed for 20-ton wagons. Further additions to the London and North-Eastern Railway Company's oil jetties at Salt End, Hull, are being made. At New Holland the London and North-Eastern Railway Company is engaged in the reconstruction of the pier head approach. The company has also completed the new dock gates at Tyne Dock, and similar replacements are in hand at some of the Hull docks. At Grimsby the railway company made further additions to the accommodation for the fish trade.

Scotland.—The Leith Dock Commissioners resolved to postpone further consideration of their scheme of dock extension, for which they obtained Parliamentary powers last Session. Work is proceeding on the Shieldhall Dock scheme of the Clyde Trustees.

Other Ports.—The Dover Harbour Board obtained the powers sought by the Bill deposited by it in the last Session of Parliament, but it has not yet begun the work of closing the western entrance to the harbour.

The Southern Railway Company completed the reconstruction of the pier head and landing stages at the eastward end of its pier at Ryde. The new deep water quay at the Alexandra basin was completed by the Dublin Port and Docks Board. The Falmouth Dock and Engineering Company is adding to its dry dock accommodation by the construction of a fourth dock 600ft. in length and 80ft. in width at the entrance. The harbour of St. Peter Port, Guernsey, is being improved by dredging and the construction of a new jetty, 600ft. in length, projecting from the St. Julian's Quay. At Scarborough the Fish Quay on the West Pier has been widened for a length of 400ft. and its foundations made secure by sheet piling, the whole of the work being carried out in reinforced concrete. A new reinforced concrete wharf 500ft. in length and about 40ft. wide is approaching completion on the north side of the Old Harbour, and the dredging of about one-half of the basin of the Old Harbour adjacent to the above works will, it is hoped, be completed this spring. The cost of the completed works will amount to about £37,000.

Naval Dockyards.—In spite of the annual vote for the Admiralty Works Department for last year being considerably less than what was being spent immediately before the war, large additions are being made to the oil fuel installations of the Navy both at home and abroad. These works, including provision for storage and the construction of oiling jetties, account for a large part of the annual expenditure. At Devonport the widening of the entrance to No. 5 basin is in hand.

British Waterways.—In July the last of the four new locks on the Trent Navigation between Newark and Nottingham, that at Hazelford, was opened by the Minister of Health, Mr. Neville Chamberlain. The construction of this lock practically completes the improvement of the river Trent, which has been in course of execution during the past four years, at a cost of about £400,000.

The Commission appointed by the Ministry of Agriculture and Fisheries last year to investigate the drainage and navigation of the Great Ouse reported in January. As a result of this report steps are being taken to reconstitute the Drainage Board, and river improvement works of some magnitude are contemplated. An ambitious proposal to construct a ship canal between the river Trent and Doncaster was announced in November, and aroused some interest in the South Yorkshire area.

European Ports and Waterways.

The financial condition of France continues to have an adverse effect on public expenditure on port works and inland navigations. The outstanding achievement in France which has to be chronicled in the year under review is the opening of the Rove Tunnel in October. This great tunnel, 4½ miles long, has taken twenty-three years to complete. It is the principal work on the new canal route between the Rhone at Arles and Marseilles and has a width of 72ft. and a height of 37ft. 6in. above water level, with a water depth of 13ft. The canal is expected to be of great importance to the port of Marseilles, providing as it does additional quay accommodation in the Etang de Berre and opening up the port to barge traffic on the Rhone. The upper section of the new waterway, that between Arles and Bouc, is still incomplete.

The large dry dock at Havre, the construction of which was started in 1911, is still unfinished, but will, it is said, be opened this year. It will be remembered that this dock is built in and upon a huge steel caisson framework, which was floated into position over the site of the dock previously dredged to the required depth and there sunk in place.

A commencement was made with the extension of the Wilson Quay at Nantes.

Some development of mechanical haulage is in progress on the northern canals of France, where both electric tractors on rails and caterpillar road tractors are being employed to an increasing extent. The results so far obtained appear to indicate that the former system has economic justification only in cases where the traffic is intense.

In Italy much activity is being displayed in connection with new port construction. Extensive quays are being built at Genoa, Naples, Catania and Palermo, at all of which places concrete block construction on rubble bases has been adopted for recent works of this description. At Leghorn and Venice monolith construction is being employed for the new quays, where foundations have to be sunk through a considerable depth of soft ground. For the Masaniello Mole at Naples and at Cagliari reinforced concrete caissons sunk on the sea bed or on rubble bases are being employed for the construction of quay walls. Cellular or "cyclopaen" block construction has been adopted for numerous breakwaters and moles now being built in Italy at the present time. These blocks are usually of large dimensions, weighing in some cases over 400 tons. Such works are now in hand at Naples, Genoa, Palermo, Catania and Bari. The improvement of the entrance channel from the Lido to the Port of Venice is a necessary sequel to the construction of the new commercial port of the city on the mainland at Marghera, and the first section of this work, providing for a depth of 11 m. and a width of 150 m. in the Lido entrance, is expected to be completed this year. The Marghera Port does not appear up to the present to have attracted a large volume of trade.

The important dock extensions at Antwerp, which are the largest port improvements undertaken in Belgium since the war, made steady progress during the year. In addition to the construction of the Kruisschans lock, the *bassin-canal* between the lock and the old docks is nearing completion. This link will be 5 kiloms. long, and have a minimum width of 300 m. The connecting passage leading to the old docks as well as the lock and *bassin-canal* are expected to be ready for opening about the end of the year. Antwerp is expending over two million pounds on these works. The traffic of the port, which before the war averaged about 14 million tons annually, reached in 1925 a total of over 20 millions. The new fishery harbour at Ostend made good progress and the works are nearing completion.

In Holland the construction of the new lock at Ymuiden, which will be one of the largest in the world, is expected to be completed in 1928. It is stated that the enlargement of the ship canal between Ymuiden and Amsterdam will be commenced during this year. The improvement of the waterway from the German Rhine to Rotterdam is one of the

most important undertakings carried out by Dutch engineers in recent years. One of its principal links, the river Noord, is now being widened throughout its length to 200 m., a work which, it is expected, will be completed in 1928. Other works connected with inland navigation in Holland which are in progress at the present time are the improvement of the Dordrecht and North Sea Canal and the construction of a new waterway from the river Waal at Nijmegen to the river Maas. The latter undertaking is expected to be opened in 1927.

The opening of the new Rhine port of Basle was celebrated during the summer, when an international inland navigation exhibition and congress took place in that city. There is now in operation a direct barge service between Basle and Rotterdam.

The first portion of the new commercial and industrial port of Budapest will, it is said, be completed during the year.

In Spain, harbour works of some magnitude are in course of execution at Bilbao, Huelva, Valencia and Barcelona. At Valencia the construction of a new northern breakwater and eastern wharf is in progress. The contract for the new quays at the Piræus, the port of Athens, was given to a French contractor and work was commenced. The Sulina bar at the mouth of the Danube continues to cause trouble, and active dredging operations were carried on during the year. The new dredged channel was brought into use and the old ones closed.

North and South America.

The ports on the Atlantic seaboard of the United States continue to develop on the lines of the construction of long narrow piers. For instance, the recently constructed City of New York piers on the Staten Island water front, twelve in number, are only 125ft. wide, and each is over 1200ft. long. The Federal Government, which is responsible for the navigable channels of the United States harbours and waterways, continues to expend large sums on their improvement. The annual appropriation from national funds for this purpose has in recent years exceeded 13 million pounds. The vast Army base terminals of the war period at Boston, Philadelphia, Norfolk and Newark are now leased to and operated by private concerns. Albany, 153 miles up the Hudson River from New York City, is planning deep-sea terminals, and the Federal Government has, in anticipation of these works, undertaken the deepening of the river channel up to the city to 27ft. The city of Norfolk has recently completed the construction of new piers—wider than the generality of those in the Atlantic ports—and a million-bushel grain elevator. At Baltimore, Philadelphia, Wilmington and Charleston there is much activity in pier construction and other port improvements. At nearly all the ports of Florida and the Gulf of Mexico extensions are in progress to an unprecedented extent. Undoubtedly, the Gulf ports, like those on the Pacific slope, have enjoyed a great impetus to trade as a result of the opening of the Panama Canal. Even greater activity is found in the ports of the Pacific seaboard. Los Angeles again boasts of being the second United States port in point of tonnage, and, while oil export still forms the greater part of its trade, general cargo business is growing rapidly. San Diego, Long Beach and the San Francisco Bay ports are among those the development of which at the present time is most marked. A notable recent development at Portland, Oregon, is the completion of a powerful Diesel-electric suction dredger, the largest yet built, which worked satisfactorily during the year. Four sea-going hopper dredgers, also operated by Diesel-electric power, were placed in commission by the Federal Government towards the end of 1925, and are reported to have worked since with very satisfactory results in several Atlantic ports. All these are electrically equipped throughout. The Panama Canal has been free from interruption to navigation by reason of landslides since 1920, although there have been movements of minor importance at Culebra. The Joint Commission of Canadian and United States engineers which has been studying the problem of deep-water navigation development between the Great Lakes and the St. Lawrence reported during the year. The Canadian and the United States experts disagreed. Alternative projects for an all-American ship canal from the Great Lakes to New York are being studied by American engineers. The cost of any one of these huge schemes for waterways between the Lakes and the sea has been estimated as likely to exceed 100 million pounds.

In Canada the trade prosperity of the past year accelerated the extension of port facilities which has been so marked in all parts of the Dominion since the war. Montreal, despite the fact that navigation is closed for five months in each year, again retains the position of exporting the largest quantity of grain of any seaport of the world. In 1925 a new record for the port was established by a shipment of over 166 million bushels. Extensions of grain storage and shipping facilities are being made at all the Canadian grain ports. It is reported that an elevator of 2½ million bushels capacity is being built at North Vancouver, another of a million bushels was recently completed at Prince Rupert, and a similar installation is now being built at Victoria. The new dry dock at Esquimalt—see one of our Supplements last week—one of the largest in the world, was completed during the year, and is now in use. Canada now has three dry docks having a length of 1000ft. and over, viz., those at St. John, N.B., Quebec, and Esquimalt. The St. Lawrence navigation has been improved by the dredging of the new north channel in the river below Quebec. This work, which has been going on for the past ten years, is expected to be completed by the middle of this year, when the depth of water in the channel will be not less than 35ft. At Montreal a good deal of rock cutting and dredging was done in the central harbour and the reconstruction of many of the old quays is now being carried out. At St. John's, Newfoundland, a dry dock was reconstructed and enlarged. Steady progress continues to be made on the construction of the new Welland Canal linking lakes Erie and Ontario. Several new contracts were placed during the year for sections of the work. This gigantic undertaking is, however, still far from nearing completion, and the most optimistic estimates do not anticipate the opening of the new waterway to through traffic before 1931.

In South America port construction was active in 1926. The seaward extension of the breakwater at Valparaiso was continued; the outer end of the structure will have its foundation at a depth of 147ft. below mean sea level. It is the most noteworthy port work now being carried out in South America, and the depth of water in which it is built is considerably greater than obtains in the case of any other harbour construction in the world. At Antofagasta one section of the new breakwater works was completed during the year. This structure, built in an average depth of water of over 80ft., is of concrete block construction founded on a rubble mound at a depth of about 32ft. Other works at this port, including quays, breakwaters and jetties, are in progress. The scheme of port construction which is now in hand is estimated to cost over three million pounds. Valdivia, a Chilean river port, is being improved by dredging and other works at a cost of over one million pounds. Harbour work is also in progress at Constitucion. A contract is being entered into for the construction of port works at Callao in Peru, and from Buenos Aires it is reported that the extensions of the harbour works which were suspended for some time are being resumed. The Argentine Government has recently approved an extensive scheme of port development which will affect a large number of harbours, including some of those on the Patagonian coast. At Rio the port improvements appear to be making marked progress after a period of comparative stagnation. The anchorage is being deepened to 10 m. and an addition of 1625 m. is now being made to the deep-water quayage. At Santos, another Brazilian port, extension works, estimated to take from eight to ten years to complete, were begun, a contract having been entered into by the Santos Docks Company during the year.

Africa.

In South Africa the Table Bay harbour development scheme is proceeding rapidly and good progress is being made with the breakwater extension, the reclamation and the new quays. What is known as the modified southern scheme of further improvements at Table Bay, which is estimated to cost over 2½ million pounds, was sanctioned and work on it started. At Port Elizabeth nearly one-quarter of the total length of 8500ft. of the new breakwater was completed. A Commission reported in the course of the year on the alternative schemes for further harbour development at Port Elizabeth which were submitted to the Government by the consulting engineers, Mr. M. F. G. Wilson and Mr. G. F. Nicholson. No decision, however, has yet been come to as to the adoption of any one of these schemes. At Walvis Bay, the only important harbour on the coast of South-West Africa, a new basin and wharf, together with the approach channel leading thereto, were completed. These works provide for a depth of 30ft. throughout the entrance channel and of 33ft. alongside the wharf at low water. The company known as Beira Works, Ltd., which has acquired the port of Beira, has already commenced some of the contemplated improvements in the port, including the construction of the new wharves and the dredging of the harbour. The passage of the East African Loan Bill through Parliament will provide funds for the construction of two additional deep-water berths at Killindini, which, it is expected, will be put in hand at an early date. Coaling and oiling jetties are also to be constructed, and a considerable expenditure on the equipment of the existing wharves is to be incurred. During the year a portion of the deep-water wharves which have been in course of construction at Killindini for the past three years was completed and brought into use. The Takoradi harbour works on the Gold Coast made good progress and nearly two-thirds of the breakwater construction was completed. A portion of the new berthage accommodation was used for the first time during the year.

In Northern Africa the construction of the new Mustapha basin at Algiers, which was commenced in 1923 and the new jetty, 5000ft. long, begun in 1924, made progress. The walls of the former are constructed of superimposed concrete blocks, the largest of which weigh as much as 400 tons, founded on a rubble mound base. The jetty is of the vertical wall type on a rubble base. Here again 400-ton blocks are being used. At Bizerta, in Tunis, the damage to the mole, the result of a great storm in 1915, is being made good by the reconstruction of a length of over 600ft. The great outer breakwater 2100 m. long and new quays were completed during the year at the port of Casablanca in French Morocco. At Port Sudan two new coaling berths and other improvements are in hand. The Suez Canal in 1925 passed nearly 27 million tons of shipping, which constitutes a record. The execution of the 1921 programme of improvements is proceeding rapidly. This, it will be remembered, aims at a depth throughout the canal of 42ft. 6in., as well as the widening of the deep-water channel throughout the navigation and the reduction of curves. At Suez an extension of the west breakwater of the Egyptian Government harbour is now being made. The International Commission of engineers which went to Egypt in December, 1925, for the purpose of reporting to the Egyptian Government on harbour matters concluded their investigations early in the year and submitted schemes dealing with the port of Alexandria, the Nile mouths and other harbour proposals.

The East.

The date anticipated for the opening of the new King George Dock at Calcutta, work on which was started in 1920, has now been extended to 1928. This important scheme, which will ultimately add nearly 200 acres of water space to the Calcutta docks system, however, made good progress during the year, and orders were placed for a large part of the electric cranes which are to be erected on the dock sides. The Trustees are also constructing a new lock entrance 80ft. wide at the old Kidderpore docks. The expenditure of the Port Trust on the new King George Dock scheme considerably exceeded one million pounds during the past year. The Trustees of the Port of Bombay have under consideration the construction of very large new docks at Trombay, in the upper part of the harbour above Elephanta Island. The Back Bay, Bombay, reclamation scheme was the subject of protracted inquiry by a Viceregal Commission appointed to investigate the inception and execution of this vast work, which already, though far from reaching completion, has involved an expenditure considerably in excess of the estimate. In the meantime work on some parts of the reclamation is being proceeded with and the report of the Commission is expected to be issued in a few months. At Karachi some additions to the wharfage accommodation were brought into use during the year. The latest section of wharfage now being carried out is being built of concrete monoliths. At Rangoon additional wharf construction is in hand and an extensive scheme for the further development of the port has recently been approved. New deep-water quays on the north side of the harbour, which will have a depth of 33ft. alongside, are being built at Madras. Among the smaller Indian ports Chittagong is rapidly reaching a position of importance. A new dredger has been ordered from England and river training walls are under construction. In the case of Vizagapatam a scheme for the development of the harbour, to be spread over a number of years, has been approved and work is proceeding rapidly on the first section of it. For some years attention will be directed to the dredging of the harbour and entrance and the construction of wharves which will afford berthing accommodation having a depth of 30ft. below low water. Two large dredgers, one of which has already been completed, have been ordered with a view to the extensive dredging work which will have to be undertaken. New harbour construction is also in hand at Tuticorin and Cochin.

Work is beginning to be active in connection with the new naval base at Singapore. The reclamation and drainage of the swamp-land is in hand. Dredging on a large scale has been commenced, and some structural work is in progress. A contract was placed by the Admiralty in November with Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, for the construction of a floating dock for Singapore. This dock will be 850ft. in length by 170ft. in width, and will have a lifting capacity of 50,000 tons. The new channel to Basra, which has been dredged through the bar at the mouth of the Shatt-al-Arab, was completed in April and opened by King Feisal. The dredging work, which has been actively carried out since 1924, now enables vessels drawing 24ft. to pass up the river to Basra, and it is intended further to deepen the waterway to permit of ships drawing 30ft. navigating it. The work has been executed by suction dredgers, which are said to have excavated 16 million tons of material.

In the Far East it is noteworthy that the Japanese have not only now made good the very extensive damage to the port works at Yokohama, occasioned by the disastrous earthquake of September, 1923, but have already embarked on large extensions of quayage, which will add materially to the trading capacity of the port. The new outer harbour at Macao is reported as nearing completion.

Australasia.

Work is proceeding at Melbourne on the Appleton Docks extension, commenced about three years ago. These works will occupy about ten years in construction, and the Harbour Trustees are at present expending over one million pounds annually on the scheme

and in deepening the existing channels of the harbour. A new port is being constructed at Coff's Harbour, on the eastern coast of New South Wales, about 300 miles north of Sydney. The works include the construction of two breakwaters, one of which is already completed. These will provide a sheltered anchorage of 100 acres, having a depth exceeding 30ft. Additional facilities for dealing with wheat shipments are being provided at Sydney. At Fremantle, in Western Australia, the Harbour Trustees are rebuilding the Victoria Quay, and at Albany, in the same State, the harbour is being dredged to a depth of 33ft., and new wharf construction, which, when completed, will be over two miles in length, has been commenced. At the present time the Federal Parliament is considering several schemes for the development of port sites in the Northern Territory of Australia. Wharf building and large dredging operations are in progress at Geelong, the second port of Victoria.

The principal harbour work at present being carried out in New Zealand is at the port of Gisborne, where the harbour is being deepened to 30ft. at low water, and large extensions are in hand.

Physical and Optical Societies' Exhibition.

No. II.*

A PHOTO-ELECTRIC rating machine for lamps—see Fig. 7—was among the exhibits of the Research Laboratories of the General Electric Company. By means of this machine, the voltage rating of gas-filled or vacuum lamps can be determined automatically and rapidly with a high degree of accuracy. The lamps are rated by determining the voltage at which the colour of their light is the same, by bringing them in turn over a pair of photo-electric cells, one

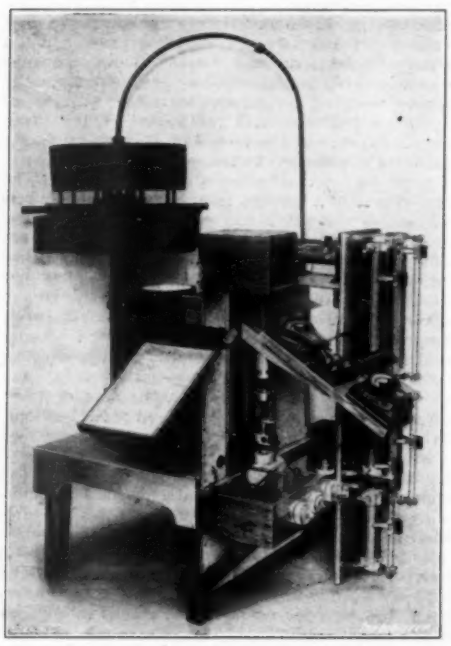


FIG. 7—G.E.C. MACHINE FOR RATING ELECTRIC LAMPS

filled with sodium and the other with rubidium, which are sensitive to different parts of the spectrum. The ratio of the currents through the cells is then determined by the spectral distribution, *i.e.*, the colour of the light, and is independent of its intensity. If the cells are so adjusted that the currents through them are equal for one lamp they will be equal for any other lamp of the same colour. The cells are connected in series and the equality of the currents is indicated by an absence of deflection of an electrometer which is joined to their common electrode.

Fig. 8 is a diagrammatic drawing of the machine. Six lamps, 1, 2, 3, 4, 5, 6, are held in lamp-holders attached to spokes of the rimless wheel *a*. The number of these lamps is determined by the requirement that the period required for the lamp to take up a steady state shall not be greater than that occupied in a revolution of the wheel during which all the lamps are tested. Six lamps are sufficient for this purpose if the lamps to be tested have already been aged, but if new lamps were to be tested about thirty lamps would be required.

The wheel *a* is mounted on a bearing near the top of the fixed support *b* on the base *c*; and it can be turned by hand to bring each lamp in turn above the photometric-apparatus—position VI. The lamps are put on and taken off at position I., where they are not supplied with current. In positions II., III., IV., V. they are connected to a supply at approximately constant voltage, and are thereby brought to a steady state. In position VI. they are connected to a supply which can be regulated for rating. These changes are made by means of brushes *d*, *d*, in contact with commutators *e*, *e*. Each commutator is divided into three parts, e_1 being dead, e_2 connected to the constant supply, and e_3 to the regulated supply.

The lamp-holders are surmounted by caps $f_1 \ldots f_6$, each of which in turn becomes the lid of a light-diffusing box when the tube *g* is raised by the vacuum lift *h*. The bottom of the box is the top of the rotating housing of the two photo-electric cells, i_1, i_2. The enclosure is light-sealed when *g* is raised by the overhanging cap at the top and by the labyrinth *p* at the bottom, the tube *g* being painted black outside and white inside, while the top of the rotating housing and the caps *f* are painted black. The only part of the enclosure which reflects any appreciable amount of light is common to all lamps, and variations in the diffusion of the light from different lamps by differences in the enclosure are avoided. The direct rays from the lamp are cut off from the photo-electric cells by the white screen *j*. If, therefore, the lamps are geometrically similar and are similarly placed in the enclosure, that enclosure should act in the same manner as an ideal photometric sphere, although it departs from it so widely in form. The rotation of the cells serves to make the approximation to the ideal condition still closer.

The vacuum lift *h* is controlled by a foot pedal connected to a valve (not shown), and is worked by the

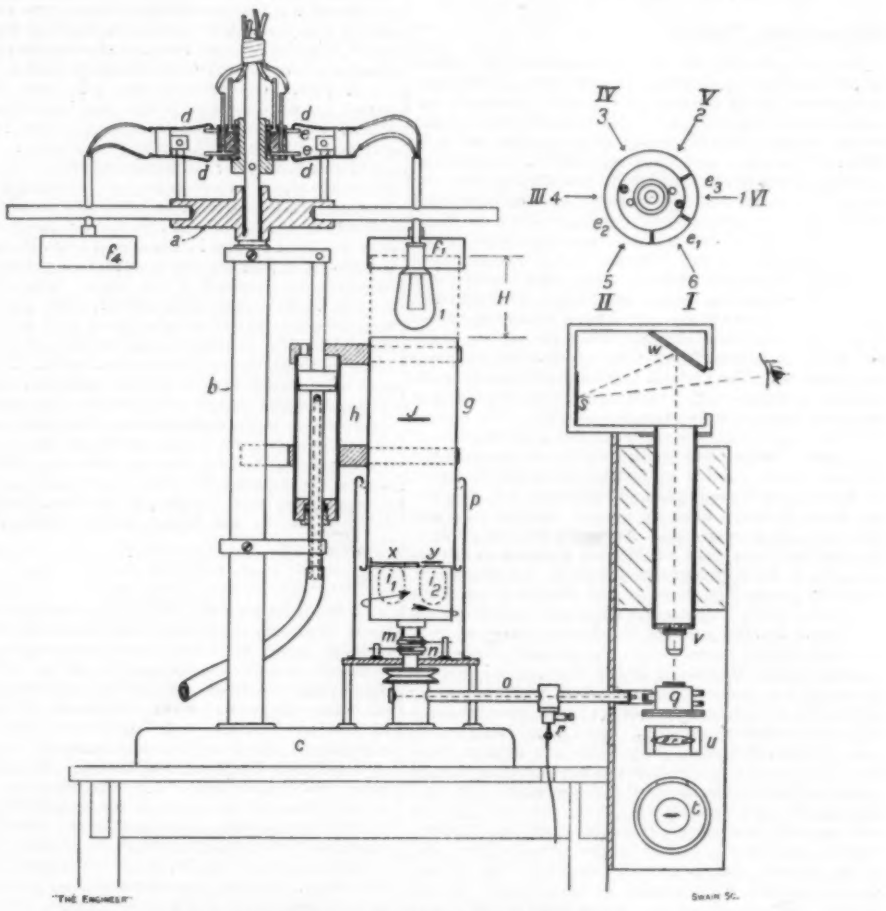


FIG. 8—ARRANGEMENT OF LAMP RATING MACHINE

operator who turns the spoked wheel. A method of working is adopted in which accurate adjustment of the photo-electric cell shutter to give a balance at a prescribed efficiency is unnecessary; and there is no serious inconvenience in making the adjustment when the housing is at rest and the tube *g* lowered. The sodium cell is, therefore, partially covered by a simple shutter *x* rotating round a pin on the top of the housing, whilst the rubidium cell is covered by a No. 9 Wratten filter *y*, on which ink can be placed if it is necessary to reduce further the current from this cell.

The housing is driven by a belt from an electric motor. The battery connections are made through slip-rings *m*, *n*, the connection to the electroscope *q* through a central rod dipping in a mercury cup (not shown), and a fixed shielded conductor *o* which can be earthed by the switch *r*. The insulation of this conductor is of sulphur.

The electro-meter is a Lindemann quartz needle instrument made by the Cambridge Instrument Company. It reads very quickly, and its zero is remarkably stable in spite of changes of temperature and level, and it is, therefore, particularly well suited for determining a balance. Movements of the needle are observed by projecting its image on a screen *s* by means of the lamp *l*, lens *u*, microscope objective *v* and mirror *w*.

The machine has to be calibrated by the use of standard lamps of which the rated voltages are known, and which are of the same wattage and filament form as the lamps to be tested. If the problem is to determine exactly the voltage at which a number of lamps have the same efficiency as the standard lamp run at, say, 200 volts, the standard is introduced into the machine, and the shutter set so that a balance is obtained when the voltage is 1 or 2 per cent. greater than 200. The voltmeter is now adjusted by a rheostat in series with it until it reads 200. The test lamps are now introduced and the voltage on them varied till a balance is obtained, and their rated voltage is then that read on the adjusted voltmeter. This is true in virtue of the law of equivalence which is accurately valid for vacuum lamps of similar type, but it is not accurately true for gas-filled lamps, although departures from it are too small to be appreciable when a limit to sensitivity is set in any case by the scale divisions of a voltmeter.

The machine is affected, like all photo-electric apparatus, by a slight drift and the voltage required to balance does not remain perfectly constant. If the greatest accuracy is required, the drift must be corrected by putting the standard round the machine at regular intervals and readjusting the voltmeter, but the drift never causes changes of more than 1 per cent. in the rated voltage, and if such an error is permissible, the shutter and the shunt can be set once for all in the positions appropriate to lamps of a given type, and the machine used from day to day without alteration.

If the problem is merely to determine whether the rated voltage lies within certain limits, the limiting voltages are applied in succession, and the lamp will pass if the corresponding deflections are in opposite directions. A standard is used in calibration in the same manner, the limiting voltages being adjusted by the law of equivalence to avoid the necessity of very careful setting of the shutter. Circuits whereby this adjustment can be made with the necessary accuracy are easily devised.

A new type of level was exhibited by the Research Laboratories of the General Electric Company. A tungsten wire, which may be in the form of a V-shaped loop—see Fig. 9—is fixed vertically on a base and the length is proportioned so that it is very nearly unstable. An indicator is fixed to the top end of the wire and the arrangement constitutes a very sensitive level, for a small displacement of the base gives a comparatively large movement of the upper end of the wire. The sensitivity is controlled for any particular wire by adjusting the length when the instrument is assembled. A sensitive electroscope is also being developed, in which similar use is made of a V-shaped tungsten loop, and in this case it is proposed to regulate the sensitivity of the instrument by rotating the loop about a horizontal axis. Models illustrating the working of these instruments were made up for the exhibition, and diagrams—Fig. 9—help to clarify the description.

The continuous wave transmitter—shown in Fig. 10—was exhibited by the Radio Communication Company, the input rating being 1½ kilowatts. It is of the

* No. I. appeared January 7th.

standard type employed for marine and land station service, and is designed for operating on wave lengths from 500 m. to 3000 m. with a normal marine range of 1000/1500 miles, although this is frequently more than doubled under favourable conditions. Provision for I.C.W. working can be included. The circuit

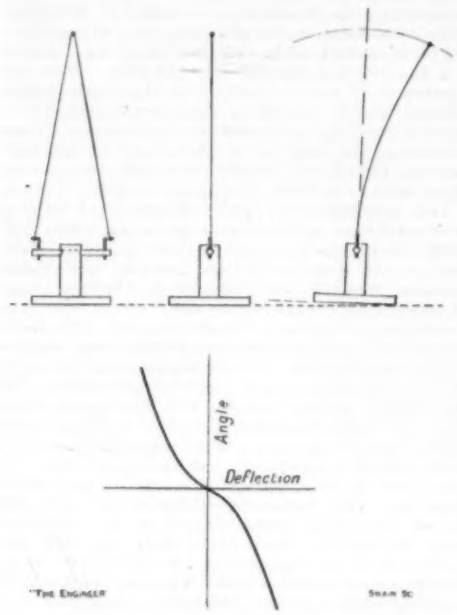


FIG. 9—G.E.C. TUNGSTEN WIRE LEVEL

employed is that designed by the British Admiralty. Only a single inductance is used, and the wave length can be varied over wide limits by altering a single connection thereto without readjustment of the grid or anode tappings. In order to avoid the use of high-

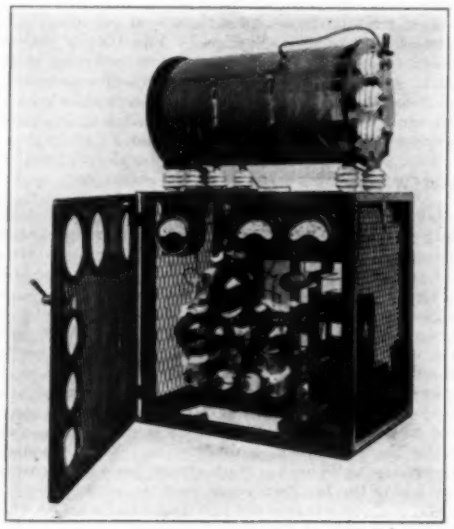


FIG. 10—R.C.C. 1½ K.W. CONTINUOUS-WAVE TRANSMITTER

frequency chokes in the high-tension feed circuit, the anode is earthed, and the filament transformers are insulated to stand high-frequency potentials. The grid excitation is obtained by a tapping on the main oscillating circuit, so that the phase of the applied

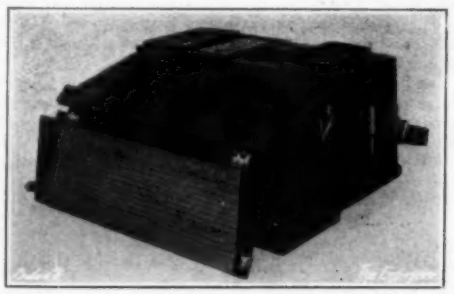


FIG. 11—RECORD BRIDGE OHMMETER

e.m.f. is accurately determined and high efficiencies on all wave-lengths are obtained.

The Record Electrical Company, Ltd., of Broadheath, Manchester, was exhibiting a bridge ohmmeter which will measure resistances from ·01 ohm. up to 999,900 ohms. on the bridge, and from 10,000 ohms. to 100 meghoms on the ohmmeter scale, and it also indicates a short circuit or open circuit. The makers point out that this instrument, which is illustrated in Fig. 11, differs from all other types, because its wide range of measurement can be carried out by one instrument, whereas other types employ two separate pieces of apparatus. Tests can be made consecutively by the ohmmeter and bridge method by moving a switch, the resistance under test always being connected to the same pair of terminals. The weight of the complete instrument is only 13 lb.

It is now realised that instruments for the visual observation of boiler-house data should be so designed that their indications can be read easily and quickly, in order to enable the workmen concerned to concentrate their time and energy to the work of increasing the efficiency of the stoking. A patented illuminated dial CO_2 indicator, exhibited by the Cambridge Instrument Company, has been designed to meet this

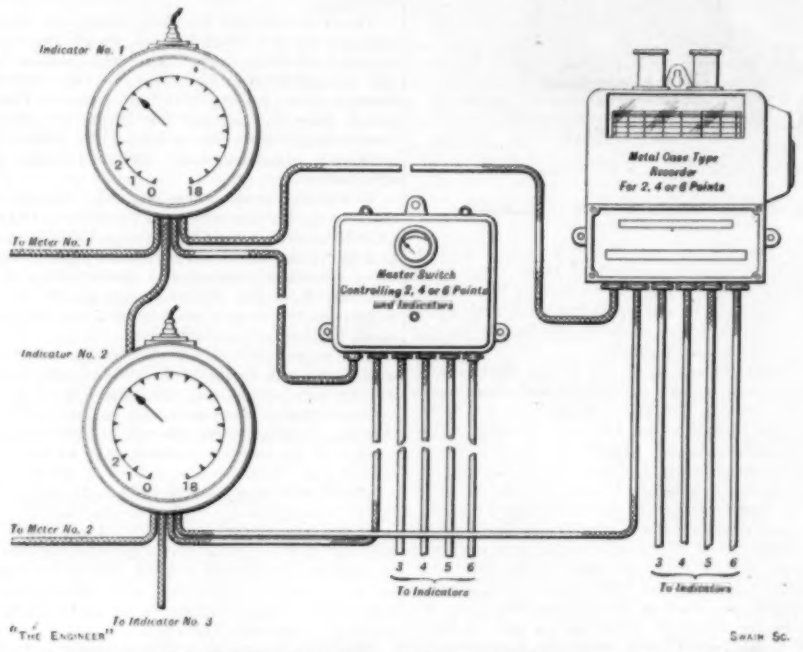


FIG. 12—ARRANGEMENT OF CAMBRIDGE CO_2 INDICATORS AND RECORDER

demand, and it possesses several novel features. It enables the percentage of carbon dioxide in the boiler flue gases to be read at a glance from a considerable distance. The dimensions of the dial—13in. diameter—are as large as are consistent with considerations of convenience of installation and attractiveness of appearance, while by using a novel method of dial illumination the CO_2 percentage is shown with exceptional clearness, and in such a manner that, except on rare occasions, it is unnecessary to read the actual percentage figure, since the general appearance of the dial at any moment gives a definite indication of the combustion conditions. The actual figure representing the CO_2 percentage is illuminated by a white light, while the pointer, in line with it, is illuminated by a green light if the percentage is increasing, and

FIG. 13—CAMBRIDGE SURFACE PYROMETER

by a red light if it is decreasing. The position of the illuminated spot on the dial, combined with the colour of the pointer, enables the stoker to gather at a glance valuable information regarding the progress of combustion. The instrument possesses a further advantage over other types of indicators, inasmuch as its erection in a dark corner of the boiler-house results in readings being more easily taken. The scale is graduated in CO_2 percentages, the standard range being 0/18 per cent.

The working of the indicator is based upon the makers' well-known electrical method of CO_2 measurement, the instrument being connected up to a CO_2 meter or katharometer, soot filter and aspirator. An important departure from the ordinary design has been made, however, in order to make the indicator itself robust. The galvanometer for the Wheatstone Bridge circuit forms a separate unit which may be placed some distance away from the boiler plant. This galvanometer may be arranged to operate two, four or six indicators in an installation, being automatically connected up to each dial indicator—with its corresponding CO_2 meter—in turn by means of a meter switch operated by an electrically controlled balance wheel. The apparatus thus has the advantage that separate indicators of a purely mechanical construction may be installed at each boiler, while the complete installation is entirely automatic in operation. The addition of a standard multi-point thread recorder to the equipment enables the management to keep a constant check on the work of the stokers.

The general arrangement of the instruments in a six-point combined indicating and recording set is shown diagrmmatically in Fig. 12. The operation may be briefly described as follows:—A pendulum contact maker continually makes and breaks an electric circuit, and thus operates two electro-magnets. One electro-magnet operates the master switch, while the other operates a chopper bar mechanism which depresses the galvanometer pointer at regular intervals on to one of the two contacts, depending upon the direction of its deflection.

By its rotation the master switch connects each CO_2 meter in turn—for a definite period—to the corresponding indicator and to the galvanometer. When there is a change in the CO_2 percentage in a flue, the galvanometer pointer will be deflected, and each time it is depressed by the chopper bar, it will close an electric circuit which energises one of two electro-magnetically operated pawl and ratchet mechanisms in the indicator, and thus rotates the indicator pointer in the corresponding direction. As the pointer rotates, a contact arm is moved over a circular rheostat and so re-balances the Wheatstone Bridge circuit. When the illuminated pointer moves up the scale, a green screen is automatically introduced into the path of the light which illuminates the pointer. Similarly, when the pointer moves down the scale, a red screen is brought into position. The electrical current required for the Wheatstone Bridge circuit, and for operating the master switch and indicators, is supplied from an ordinary battery.

A small but useful device shown by the Cambridge Instrument Company was the surface pyrometer—illustrated in Fig. 13—for taking the temperatures of heated curved surfaces under working conditions. It is useful in securing even heating over calendering bowls, paper-making rollers, vulcanising-press platens, &c. A thermo-couple, consisting of a thin strip of copper and constantan with the junction at its mid-point, is stretched across the ends of an inverted bow spring fixed to the underside of a metal casting, and its ends are connected to a millivoltmeter mounted on the casting. The thermo-couple strip is pressed into contact with the heated surface and a steady reading of the temperature of a clean surface is obtained on the indicator scale in three to five seconds. The standard ranges are 0-400 deg. Fah. or 0-200 deg. Cent.

The Foster Instrument Company, of Letchworth, was exhibiting, among other things, a sparking plug thermo-couple pyrometer—as shown in Fig. 14. An ignition plug, which normally serves the usual purpose, is designed to measure the mean temperature inside the combustion chamber of an internal combustion engine. The special plug is connected to a portable indicator by means of cab tire compensating leads, the indicator being fitted with an automatic cold junction setting device. The investigation of the mean temperature existing in an internal com-

bustion cylinder under various conditions of load, is of particular importance in connection with the life of the valves, &c.

With any ordinary form of thermo-couple it is impossible to measure the peak temperature at the explosion, owing to its extremely short duration, but the peak temperature is not so important from the point of view of valves as the mean temperature throughout the cycle. While the latter is easier to

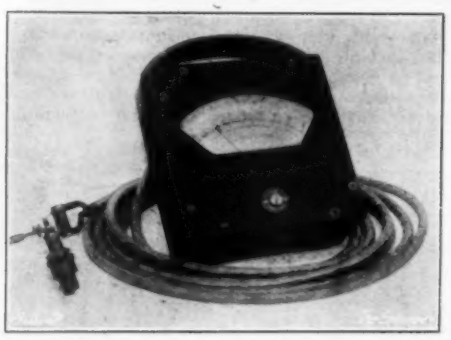


FIG. 14—FOSTER SPARKING PLUG PYROMETER

measure, the problem presented is by no means simple.

The various difficulties involved have been overcome by the Foster Instrument Company by making the centre electrode of the sparking plug a thermo-couple in concentric form, with its junction at the tip immersed in the cylinder gases.

Several other details of construction were necessary to secure satisfactory insulation and connection, and all these details form the subject of a patent. At first it was thought that the heat energy of the spark itself might seriously disturb the measurement, but experience has shown that this is not the case.

The pin jack voltmeter illustrated in Fig. 15, exhibited by the Weston Electrical Instrument Company, has been designed for testing the voltage across the valve filaments of wireless receiving sets and also for measuring the battery pressures up to 200 volts. The instrument is supplied with a pair of pin jacks for mounting on the back of the set, and the jacks are connected to the filament terminals, a pair of jacks being provided for each valve when the filaments are

FIG. 15—WESTON PIN JACK VOLTMETER

controlled by separate rheostats. When it is required to measure the high-tension battery voltage the voltmeter is removed from the panel at the back of the set, and it is plugged into the high-range stand shown, when the battery voltage is tested by means of the cables attached to the stand. The instrument has a double scale and is made for 6 and 200 volts, the corresponding resistances for these ranges being 750 and 25,000 ohms respectively.

Railways in 1926.

ACCORDING to their annual reports for 1925, the four grouped railway companies proposed to spend during the year just ended 3860 millions on capital account for new works. The industrial situation during the last eight months of the year led to many schemes being postponed and to most of the remainder being delayed. The respective chief engineers have repeated the kindness of previous years and given us particulars of what was done, and from those reports we have selected the more important works as follows.

London, Midland and Scottish.

The conversion of the Victoria and Exchange stations, Manchester, into one combined station is progressing. The widening at Kibworth is practically completed, the down loop, ¾ mile, having been brought into use on December 7th, and the up loop, 1 mile, will be opened this month (January, 1927). It is hoped that in the coming spring the two additional running lines between Coppenhall Junction, Crewe, and Winsford—4 miles—and from Hartford Junction to Acton Bridge—2 miles—will be brought into use. About 100,000 cubic yards of earth have had to be removed; three public road overbridges have been replaced by steel structures 36ft. wide; the bridge over the Shropshire Union Canal near the 164¼ milepost has been widened.

The Horbury and Wakefield widening, 3¼ miles in length, approaches completion. This particular work includes the taking down of the tunnel, 130 yards long, at Horbury. Twelve bridges have had to be widened and, by an agreement with the Wakefield Corporation, two others, which are over main streets, have had to be reconstructed so as to give a wider roadway.

The Chevet and Snydale widening includes the opening out of Chevet Tunnel, which was 702 yards in length and 95ft. deep. The first portion embraced the southernmost 1¼ miles of the widening and included the opening out of the tunnel. The two new goods lines throughout the length of this contract were brought into use on July 11th, 1926. The work involved approximately 800,000 cubic yards of excavation.

The second portion was begun in August, 1925, and deals with the northernmost 2¼ miles of the widening. It will be necessary to excavate 150,000 cubic yards and to widen, alter and construct eight bridges, some of noteworthy magnitude, particularly the bridge over the Aire and Calder Canal, which has a span of 105ft. on the square and 108¾ft. on the skew. The work is making good progress.

The superstructure of the bridge over the Leeds and Liverpool Canal at Leeds required renewal, and at the same time the construction of a new or a widened bridge was a necessity to meet traffic developments. Owing to the difficulty of reconstructing the bridge in its present position and at the same time keeping the traffic running over it, a new bridge was constructed alongside it in 1924 and traffic turned over it off the old bridge. The reconstruction of the old bridge is now being dealt with. It will have one span, 88ft. to 95ft. long, and the present outside girder of the bridge, completed in 1924, will be the centre girder of the complete structure, over which four lines of way will be accommodated to serve Leeds station, instead of two as at present.

The Longbridge and Barnt Green widening is the duplication of the main line, from two to four lines, for a distance of about 2¼ miles, and includes the opening out of Cofton Tunnel, which is 440 yards in length and 80ft. deep. The work was begun in January, 1926, and is being pushed on with vigorously. Nearly half a million cubic yards of excavation are necessary, about 430,000 cubic yards being in the Cofton Tunnel cutting, over half of which has now been dealt with.

Very extensive works are in hand at Tilbury. The scheme consists of the provision of a new and more commodious station, with new buildings and circulating area, and a larger deep-water landing stage in the river Thames, to be constructed by the Port of London Authority. The diversion of Ferry-road from under to over the railway was completed in May. The new bridge has five steel spans varying in length between 45ft. 6in. to 98ft. 6in., and three inclined approaches consisting partly of 25ft. steel spans, forty in number, and partly of embankment. The whole of the site was once marsh land, and is still too soft to support much weight. All the piers of the bridge, therefore, are founded on ferro-concrete piles, long enough to penetrate through the marsh to the solid gravel beneath; some 600 of these piles, 16in. square and 56ft. long, have been used. The Port of London Authority has let contracts for the landing stage portion of the scheme, work upon which is now proceeding.

London and North-Eastern.

The single line branch, 5 miles 50 chains in length, from the South Yorkshire Joint Line to Firbeck Colliery, was opened for traffic in December. The work necessitated the removal of 387,000 cubic yards of earthwork, and included the construction of a viaduct 80 yards in length built on a curve of 35 chains radius. Off this branch there is to be a new line, 1¾ miles, to Harworth Colliery, the contract for which has just been let. The line to Thoresby Colliery, 1 mile 18 chains in length, in the Dukeries was completed in September. Contracts have been let for two other collieries in the Dukeries and work thereon has been started—the Bilsthorpe Colliery branch, 3 miles 10 chains, and the Blidworth branch, 2 miles 13 chains in length.

For the heavy ironstone traffic in Lincolnshire great changes are to be made at Frodingham. They will include a new passenger station, a western curve to give access between the Doncaster-Grimsby main line and the North Lindsey Light Railway in the Doncaster direction, and a marshalling yard with twenty sidings that will accommodate 2000 wagons. The contract for some of the work was let and the work was begun. The new station at Brookmans Park, between Potters Bar and Hatfield, was opened in July. That at Welwyn Garden City was opened on September 19th.

The single-line swing bridges at Beccles and St. Olaves have been replaced by double-track swing bridges. Details of the same were given in our last annual article. That at Beccles was brought into use in July and the one at St. Olaves in September. East of Althorpe Station and of the Scherzer rolling-lift bascule bridge over the river Trent, there was a swing bridge over the canal at Keadby. It has been replaced by the drawbridge described in THE ENGINEER of November 5th, and illustrated in one of our Supplements last week. The old bridge was removed and the new one opened on June 26th. There is a number of all-timber viaducts on the Great Eastern section, and it has been considered advisable to replace them by brick and steel structures. Those now in hand or about to be renewed are on the length between Ely, March and Peterborough, two of them being 437ft. and 893ft. long respectively.

The rearrangement and extension of existing accommodation in Heaton up goods yard was completed during the year, and the new staiths at Blyth, constructed jointly by the London and North-Eastern Railway and the Blyth Harbour Commissioners, are now ready for use.

Sleekburn Viaduct, which was an old timber structure of thirteen 25ft. spans, has been replaced by an embankment, and the stream over which the viaduct was built is now carried in a culvert. The old timber viaduct, carrying the Newbiggin branch over the river Wansbeck between Bedlington and North Seaton stations, is now being replaced by a steel viaduct consisting of fourteen spans, eleven of which are of 75ft. span, two of 68ft., and one of 80ft. 9in. Very satisfactory progress was made with the erection of the steel work, and it is hoped to complete the work by the middle of this year. The new viaduct is being constructed parallel to and immediately alongside the timber viaduct, which will be removed when the steel structure is completed.

The new gates and other works in connection with the entrances to the Tyne Docks were completed. Two pairs of new steel gates of the buoyant type, with greenheart heelposts, mitres and clapping sills, have been provided, and eight new sluice doors and frames have been fixed in the masonry of the entrance piers. New gates for the Alexandra Dock, Hull, were completed during the year, but are not yet in place. The construction of a second jetty for the discharging of oil at Salt End, Hull, was started.

In the Scottish area the practical completion of Berwick Station is announced. The Hawes Pier at South Queensferry is being lengthened for about 200ft., and the railway pier at North Queensferry is being lowered. It is hoped to finish both works in sufficient time for the improvements in the Queensferry ferry service to be made next summer.

Great Western.

A good proportion of the permanent way and the platforms for the improved station at Newton Abbott was completed during the year. The main station buildings now approach completion, and the buildings on the platforms have just been opened. The second single-line tunnel, about 1600 yards long, between Colwall and Malvern on the Hereford and Worcester line, was brought into use on August 1st. The reconstruction of the station at Newport, Mon., is being proceeded with and the subway connecting all the platforms has been completed. The contract for a new carriage shed at Ebbw Junction, which is part of the Newport work, is proceeding. Very extensive alterations at Swansea, High-street, have been carried out during the last two years, and, as a result, several of the main line trains are run direct to Swansea, thus avoiding a call at Landore Junction.

Southern.

The outstanding event on the Southern Railway was the completion of the electrification of the Eastern or former South-Eastern and Chatham section. Combining the mileage just done with that on the Western or former London and South-Western section and on the Central or former London, Brighton and South Coast section, the total length converted to electrical operation is 647 track miles, and forms the largest suburban electrification in the world. The total cost has been nearly £8,000,000.

On February 28th the new services between Charing Cross and Cannon-street and Orpington, between Grove Park and Bromley North, New Beckenham and Beckenham Junction, St. Johns and Addiscombe, and Elmer's End and Hayes were brought into use. New signalling was put into service between Holborn and Elephant and Castle on March 21st, and on June 6th the new electrical services to Dartford *viâ* Greenwich and Woolwich, or *viâ* Blackheath and Woolwich or Blackheath and Bexley Heath, or *viâ* Sidcup were brought into use.

In anticipation of the new services, and to provide them with better facilities, considerable alterations were made in the track and track connections at and between Charing Cross and Cannon-street.

The easternmost side of Charing Cross Station is approached by the original bridge over the Thames, built when the line was opened in 1864, and designed for a live load of 1 ton per foot of track. The western side of the station is reached by that portion of the bridge erected in 1887, which has better loading factors. As an electrically operated train gives a live load of only 0·7 ton per foot of track it was decided that the

new service of trains should use the eastern side of the bridge and that steam working should be confined to the western side. The running lines were therefore arranged accordingly. Moreover, the sidings were so planned that, on the older portion, there was no possibility of four lines abreast being loaded simultaneously, even with carriage stock. The redistribution of the load reduced the stresses on the old structure to a substantially lower limit than that for which it was originally designed. The six platforms are now from 610ft. to 750ft. long, instead of from 542ft. to 690ft.

The alterations made at Cannon-street were of a much more extensive character and the whole of the permanent way in the station yard was rearranged and considerably simplified. The eight platforms vary in length from 567ft. to 752ft., and they are of a minimum width, except at the extreme end, of 20ft. The station was entirely closed from 3 p.m. on Saturday, June 5th, to 5 a.m. on Monday, June 28th. Meanwhile the whole of the new lay-out had been laid down on some vacant land near New Cross Gate and completely fitted with all connections, point mechanism, point locks, conductor rails, cable connections, &c. After being carefully marked at the joints with erection marks the whole was transferred by suitable instalments and in a pre-arranged order to Cannon-street, and was in position by Saturday, June 19th. The new all-electric signalling, which included four-aspect light signals, was then coupled up and trial trains ran on the following Thursday, Friday, Saturday, and Sunday. On Monday, the 28th, all was again in working order. The operations involved the removal altogether of 7600 tons of material and the substitution of 8500 tons. The connections were so much simplified that there are now only seventy-seven sets of points, as against 101 sets previously. A start was made on the laying of the conductor rails between New Cross and Norwood Junction in connection with further electrical work. Reconstruction of the station at Wimbledon was put in hand. Work on the Eastleigh and Shawford widening, 2 miles 68 chains long, where an additional road on each side of the line is being provided, was delayed by the industrial situation.

The new engine shed at Exmouth Junction, Exeter, was completed during the year. It is 270ft. long by 248ft. wide and is built in ferro-concrete. It is of the end-on type and contains twelve shed roads and one lifting road. An electrically operated turntable, 65ft. diameter, has been provided, and an electrically operated coaling plant is being installed.

The new railway, 1¾ mile in length, between Broadstairs and Ramsgate was opened on July 2nd. It joins the Faversham-Broadstairs-Ramsgate and the Ashford-Canterbury-Ramsgate lines, creating, in effect, a loop. The former line used to terminate at Ramsgate Harbour and the latter at Margate Sands, so the new line automatically closed the railway between Margate Sands and Ramsgate and the Ramsgate Harbour end of the old Chatham line, including the tunnel outside Ramsgate Harbour Station. The new station at Ramsgate has two island platforms, each 750ft. in length. An additional station was provided at Dumpton—between Ramsgate and Broadstairs—which has a single island platform 750ft. long.

During the year a large number of bridge works were carried out in order to allow the new "King Arthur" engines to run on certain continental routes. On the Victoria-Dover line seventeen bridges were renewed or strengthened between Brixton and Shortlands, and one was renewed between Maidstone and Ashford. On the Victoria to Newhaven route four bridges were renewed.

Metropolitan.

The station at Edgware-road is being reconstructed and the up and down platforms replaced by two island platforms. The platforms were brought into use during the year and the station buildings at street level approach completion.

The increased facilities given at Edgware-road have permitted for most of the Metropolitan District trains from Putney Bridge that terminated at Kensington, High-street, to run through to Edgware-road. That necessitated some changes in the track at High-street, which were carried out on November 1st.

Underground.

The extension of the Charing Cross, Euston and Hampstead Railway from Charing Cross, in a double tube under the Thames and past Waterloo, to Kennington, where a connection is made with the City and South London, and the extension of the latter line from Clapham Common to Morden were brought into use on September 13th. The single line between Hounslow Central and Hounslow West has been doubled. The additional line and a new island platform at the latter station were brought into use on December 11th.

ELECTRICALLY-DRIVEN pumps for irrigation purposes appear to be coming into popularity in China. Quite recently seven such pumps have been installed near Foochow and some others round Changchow. The Foochow sets are said to be capable of delivering some 500,000 gallons an hour.

Electrical Engineering in 1926.

No. II.*

Turbo Generator Sets.

Except for increasing the speed and output of turbo-generators, electrical manufacturers have not made any radical change in the design of these machines for some little time, but a rather unusual three-phase generator is at present under construction at the works of C. A. Parsons and Co., Ltd., of Newcastle-on-Tyne. Its special feature is that it has been wound for a terminal pressure of 33,000 volts, or about three times the usual pressure. While 30,000-volt, 5000-kilovolt-ampère water wheel alternators were built by a continental firm for the city of Rome more than twenty years ago, so far as we are aware, no attempt had prior to the year under review been made to construct such exceptionally high-voltage generators in this country. Generation at high voltages naturally offers the advantage of eliminating step-up transformers, which introduce additional loss and cost; but it remains to be seen whether the practice of building generators for such a high pressure as 33,000 volts will prevail. Much will naturally depend on the cost of construction and reliability of such machines. That generators can be constructed to operate satisfactorily at 30,000 volts is evident from the fact that the machines constructed for the city of Rome are said to have worked without a breakdown for more than twenty years. But if the cost greatly exceeds that of alternators designed for relatively lower pressures, engineers will hesitate to abandon the practice of stepping-up the pressure by means of transformers. The alternator now under construction at the works of C. A. Parsons and Co., Ltd., is a 31,250-kilovolt-ampère machine, which is to be coupled to a 25,000-kilowatt tandem reaction turbine. The lines on which it is constructed can be gathered from Fig. 4, in which the conductors that

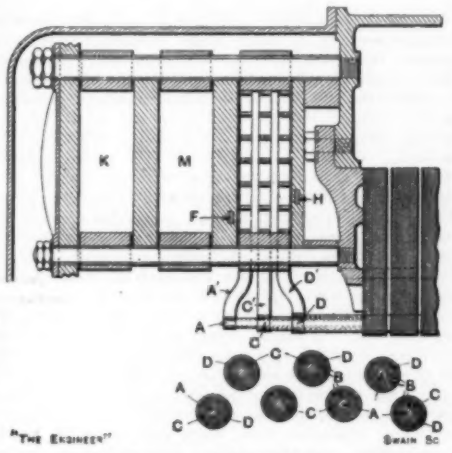


FIG. 4—HIGH-PRESSURE ALTERNATOR WINDINGS

carry the high-tension current are shown at A. These conductors are surrounded by insulation B and conductor tubes C and D, also separated by insulation, deal with lower voltages, the conductors being nested one within the other. These concentrically arranged conductors are brought out of their slots and connected to end windings A^1, C^1, D^1. Only the windings of one phase are shown, the end windings of the other phases being accommodated in the spaces K and M. The inner cores A of the various conductors in each phase are connected in series and then joined by the cross conductors F to the surrounding conductor tubes C, which are again connected in series and then by way of the cross connections H to the other conductor tubes D, which are connected to the earthed end of the winding. The voltage between adjacent conductors and earth is thus kept at a low value, so that the necessary thickness of insulation and length of leakage surface can be provided without unduly increasing the dimensions of the machine. The scheme is fully described in British patent No. 217,320, to which reference should be made for further information.

The aggregate output of turbo-generating sets and condensing plant from the Heaton works of C. A. Parsons and Co., Ltd., was normal, and there was an appreciable increase in the export trade. All the large electrical firms have, in fact, experienced a very fair demand for turbo-generating sets. The Metropolitan-Vickers Electrical Company built and tested during 1926 a set that is believed to be the largest machine that has so far been constructed for a speed of 3600 revolutions per minute. The output is 15,625 kilovolt-ampères, at a pressure of 11,000 volts, the periodicity being 60 cycles per second. As regards 3000-revolution machines built by this company, the record of 1925 was exceeded. A machine capable of developing 30,770 kilovolt-ampères continuously and of carrying an overload of 38,000 kilovolt-ampères was constructed during the year. Four Metropolitan-Vickers alternators of 44,000 kilovolt-ampères capacity, three designed for a speed of 1500 revolutions and one for a speed of 1800 revolutions per minute, are claimed to be the largest single-unit alternators that have so far been constructed in this country. A growing demand was experienced by this firm for large steam turbines, which almost without exception were built on the two-cylinder principle. For large powers the British Thomson-Houston Company has developed the two-cylinder "super-efficient" turbine, for speeds of 1500–3000 revolutions per minute, examples of the former being two 25,000-kilowatt machines for the Deptford West power station of the London Power Company, and of the latter two 18,750-kilowatt machines for the city of Coventry electricity department. The demand for turbines in which steam is extracted for process work is increasing, and the British Thomson-Houston Company has developed a turbine from which steam is extracted for the purpose of heating the whole of the feed for a complete installation, and providing steam for various purposes in very large establishments. Developments were undertaken in connection with the problem of re-heating steam in its passage through a turbine, and attention has also been given by this company to the design of turbines with capacities up to 100,000 kilowatts. The company has now adopted the principle of separate excitation for the direct-coupled exciters on large turbo-alternators, and has developed a double-purpose direct-current generator for that purpose. Applied in the manner indicated, the system ensures steady exciter voltage at the lowest loads, and as the excitation follows changes of load more quickly, the stability of the supply system is increased. An additional advantage is that a constant voltage is available for various auxiliary purposes, such as that of operating relays, signals, regulators, &c. Some large turbo-generator sets were built by the General Electric Company, including 25,000-kilovolt-ampère sets for the London Power Company and the Adelaide Municipality. Following the success attained by the installation of the English Electric Company's first 20,000-kilowatt alternator coupled to a two-cylinder impulse reaction turbine, designed for a speed of 3000 revolutions per minute, generating units with turbines of a similar type have since been built, including units of 10,000 kilowatts capacity for Dundee, Aberdeen, Preston, &c. Many gear-driven direct and alternating-current sets were also constructed by this company for use in various industrial works, and provincial power stations, the speed of the turbines in all these cases being 6000 revolutions per minute.

Mercury Vapour Rectifiers.

The makers of the glass bulb mercury vapour rectifier—the Hewittic Electric Company, Ltd.—experienced a good demand for this class of apparatus—a better demand, in fact, than that experienced in previous years. There was a marked increase in the use of the smaller types of rectifiers, especially for use with lift motors. New mercury vapour rectifier sub-stations, with capacities ranging from 50 to 750 kilowatts, were put into operation, and the call for the larger size sets, and especially 500-kilowatt installations increased considerably. Various minor developments took place. Research work is still being undertaken, but developments up to the present have not been of a startling nature. Progress during the period under review was mainly in the direction of improvements in details and the simplification for regulating the voltage of the larger rectifiers. Induction regulators are now adopted instead of the usual 11-stud tapping switch and auto-transformer placed at the base of each cubicle. Investigation and experience have shown that in the case of the larger rectifiers it is more economical to use an induction regulator for controlling the primary supply into the main step down transformer which feeds a bank of rectifiers. Apart from the economy that arises from the scheme, the induction regulator naturally gives finer regulation as well as a wider range. No new metal-cased rectifier installations were put into operation in this country during the year, but very substantial progress was made in other countries where these rectifiers are being widely used for traction purposes.

Electric Traction.

Perhaps the most notable technical development in the electric traction field was the construction by Fried Krupp of a 50-cycle single-phase locomotive, equipped with a novel type of compensated single-phase motor without a commutator, claimed to possess the running qualities of the three-phase motor. The locomotive was described in THE ENGINEER of June 12th, and is shown in Fig. 5. The advantage of using a single-phase motor is, of course, that high-pressure 50-cycle current can be collected from a single overhead wire instead of from two wires as required by the three-phase motor. In order to endow the motor with the properties of the three-phase machine, a short-circuited winding is made to rotate within the air gap so as to transform the pulsating stator field into a constant rotating field for the main rotor. Motor generator locomotives, which draw single-phase current from the overhead line and are equipped with direct-current traction motors, are becoming fairly common in America, but up to the present engines of that type have not been built in this country. A 2340 horse-power locomotive, the most powerful

* No. I. appeared January 7th.

electric engine built in this country, was completed by the Metropolitan-Vickers Electrical Company, which now has in hand forty-one goods locomotives of 2600 horse-power for the Great Indian Peninsula Railway. A fair amount of other railway and tramway work was carried out by this firm. The English Electric Company is another of the electrical manufacturing concerns that seems to have on hand some rather important traction work, notably for the Great Indian Peninsula Railway, the Harbour Commission of Montreal, and the Capetown suburban electrification scheme. For the Post Office railway the Crompton and Co., Ltd., the Metropolitan-Vickers Electrical Company, and the English Electric Company. Other activities of the last-mentioned firm in the directions of building electric winding engines, iron and steel works equipment, large transformers, &c. Many transformers were built in various works for large output and high voltages: much higher voltages, in fact, than those used in this country, and Bruce Peebles and Co,, Ltd., built a new transformer shop. For current transformers, the British Thomson-Houston Company developed a scheme of connections which enables B.E.S.A. accuracy to be

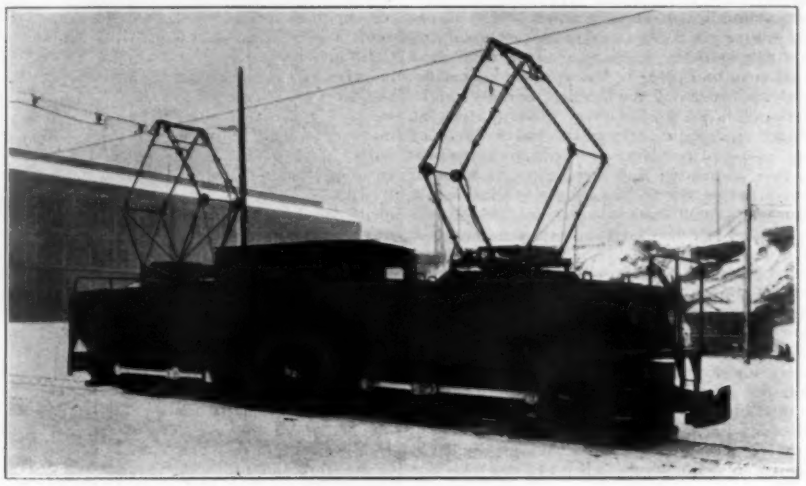


FIG. 5—50-CYCLE SINGLE-PHASE LOCOMOTIVE

English Electric Company is supplying the whole of the electrical equipment. A main line 2000 horse-power electric locomotive is being built for India by the General Electric Company.

Telephones.

The carrier system of telephony, which enables two or more conversations to be carried out on one pair of wires, is apparently making appreciable headway, for, in addition to a large installation that is being put into service in South Africa by Standard Telephones and Cables, Ltd., a contract has been secured by the same company from the Australian Government for a carrier scheme with repeaters to provide communication between Sydney and Brisbane, Sydney and Tamworth, and Sydney and Grafton. Automatic telephone exchange work is being carried out by the company for the London automatic system, the exchanges that are being dealt with being Sloane, Temple Bar and Langham. Two automatic exchanges for the Irish Post Office at Merrion and Ship-street, Dublin, are now almost completed. The London to Canterbury trunk cable, consisting of approximately 63 miles of 160 pair, 40 lb., paper coil, lead-covered cable, has also been completed. The work not only involved the manufacture of the cable, but that of drawing it into empty conduits between London and Canterbury; also the jointing and testing of the cable. At intervals of 1·125 miles loading coils are provided, there being in all 275 of these coils. The cable links up with the Anglo-Belgian submarine cable, which terminates at the Canterbury repeater station and provides through circuits to the Continent, *vid* Belgium, to cope with the increased continental traffic. A considerable amount of other important work was also carried out for the Post Office by Standard Telephones and Cables, Ltd. A new development of the company was the introduction of a cable known as the "Spiral Four," or "Star Quad," cable, for use on short trunks, and in the London area, branching from the Holborn Exchange to the districts of Ealing, Chiswick and Finchley, the company supplied and installed approximately 26 miles of 254 pair, 40 lb. conductor cable of this type. During the year approximately 200,000 loop miles of cable were manufactured at the company's works.

Miscellaneous.

Long and glowing accounts of electrical contracts carried out and at present in hand have been forwarded by the electrical manufacturing concerns, but anything beyond adding a very brief summary of this work is out of the question. The English Electric, the British Thomson-Houston, the Metropolitan-Vickers, and the General Electric companies all report notable progress in their switchgear departments, in which switchgear of very high rupturing capacity is being manufactured. There was apparently a substantial increase in the demand for outdoor substation equipment, and one firm, namely, the English Electric Company, developed outdoor switchgear for use on systems up to 220 kilovolts. Transformer kiosk sub-stations appear to be gaining prominence in this country, the firms that have taken up their manufacture being the General Electric Company, obtained from a bank of three-bar primary current transformers on a three-phase system, even with current transformers of comparatively low ratio. The demand for alternating-current motors that work at unity power factor, or practically unity power factor, such as the "no lag" motor made by the British Thomson-Houston Company, continues to increase. Owing, no doubt, to the more general adoption in this country of alternating-current distribution, high-power factor motors of various kinds are being manufactured in larger quantities than in the past. For improving the power factor of existing slip-ring motors, phase advancers are being made in increasing numbers, a new machine of this description having been introduced by the Metropolitan-Vickers Electrical Company. New applications, we are told, are constantly being found for the B.T.H. polyphase variable speed commutator motors, which are being manufactured for larger outputs than in the past. An interesting example of the use of these machines is afforded by an order from overseas for frequency changing sets, each consisting of a 210 horse-power variable-speed commutator motor coupled to a 230 kilovolt-ampère 100-cycle 550-volt alternator, with direct coupled exciter. A "true watt" motor placed on the market by Crompton and Co., Ltd., is of the type in which the excitation circuit is integral with the motor, no separate exciter being required. The fact that the motor runs at constant speed at all loads and has a leading power factor on light loads is a marked advantage. In the spring of the year Laurence, Scott and Co., Ltd., secured a direct-current motor contract, which is believed to be one of the largest contracts of the kind ever placed in this country. The motors are for the electrification of the Thames Board Mills at Purfleet, and they are of the so-called deluge pattern, which have been designed for use in situations where there is a chance of the machines being subjected to a downward stream of water from fractured pipes, &c.

PAINTS, VARNISHES AND PAINT INGREDIENTS.

THE British Engineering Standards Association has just issued new British Standard Specifications for Red Oxides of Iron for Paints, Zinc Oxide Oil Paste for Paints, White Lead and Tinted White Lead Ready Mixed Paint and Extra Hard Drying Varnish. They contain clauses regulating the composition, together with standard reception tests, for the purchase of these materials. Appendices giving methods of carrying out the tests are included. These specifications have been prepared at the request of the paint manufacturers by a committee representative of both the buying and manufacturing interests, and as in the case of all British Standard Specifications, they will be reviewed as experience of their working or progress in the industry renders it necessary, and revised issues will be published from time to time. Amongst other specifications in hand which will be published as completed are the following:—Red Oxide of Iron Oil Paste (Class 1 and 2), Lead Chromes, Prussian Blues, Lithophone, Lithophone Oil Paste, Carbon Black, Gold Size, Zinc Oxide and Tinted Zinc Oxide Ready Mixed Paint. Copies of these five new specifications (Nos. 261, 262, 272, 273, and 274–1926) can be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, S.W. 1, price 2s. 2d. each, post free.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DIRECT CONVERSION OF LOW-PRESSURE SUPER-HEATS INTO SUPER-PRESSURE.

SIR,—I was very much interested in the title of the article by your correspondent "C. R. K." in your issue of December 31st, but I was even more mystified by his account of the procedure alleged to have been invented by Perkins and adopted by Sorel and Wethered to obtain such a result. The description has perhaps suffered from the season of the year, but so far as it is intelligible to me, it amounts to this:—Feed water was pumped into a boiler with no steam space, and escaped in a highly heated condition through a loaded valve, into a superheater maintained at a red heat. From the superheater the steam "with only a very moderate steam pressure," but presumably at about 1200 deg. Fah., was "delivered" into a drum, where it was cooled and reduced to a dry or slightly superheated condition "at pressures up to 1 ton per square inch" by direct contact with a spray of water. The point I, and no doubt other readers, wish "C. R. K." to explain is how the low-pressure steam was "delivered" into a chamber already occupied by steam at "pressures up to 1 ton per square inch." If it was pumped in mechanically, what is the advantage of the process?

The last paragraph but one of the article, which purports to show "the possibilities of the special Perkins' system at ordinary pressures," really shows the possibilities of confusion of thought concerning ordinary matters. The argument of "C. R. K." appears to be as follows:—If we add about 108 B.Th.U. to 1 lb. weight of saturated steam at 200 lb. pressure, we can superheat it by 200 deg. Fah. If we add the same quantity of heat to 9 lb. of saturated steam at 200 lb., we can produce 9 lb. of saturated steam at 600 lb. pressure. He concludes that the latter alternative is the most advantageous, for the astonishing reason that 9 lb. weight of steam, after being raised from 200 lb. to 600 lb. per square inch, and then expanded down again to its original state, has a volume over six times as great as that of one-ninth as much steam at the same pressure, but superheated. Nine pounds of steam at any pressure must always have a volume many times as great as that of 1 lb. of steam at the same pressure, even if the latter is superheated to the limit of practical possibility.

If, after this, it is worth while to criticise the extraordinary article of "C. R. K." further, one might ask where the heat is supposed to have come from to make the extra 8 lb. of 200 lb. steam, assumed to exist for this wonderful demonstration of Perkins' process. Furthermore, one would like to know by what exact method saturated steam at 600 lb. is supposed to be reduced to 200 lb. pressure, while still remaining in the saturated state; becoming neither wet by adiabatic expansion nor superheated by throttling. The thermodynamics of "C. R. K." are, however, too unintelligible to discuss. If he will tell us exactly what Perkins did, perhaps you, Sir, will give us an article on the thermal advantages and disadvantages of the process, and thus add to the indebtedness which all engineers interested in high-pressure steam developments feel towards the columns of THE ENGINEER.

January 10th. ASTONISHED.

THE HARVEY COMBE LOCOMOTIVE.

SIR,—On September 24th last I asked your readers for any information to show the reason for this name being given to the Stephenson locomotive supplied in 1835 to a contractor, and shown by a contemporary print at work on the London and Birmingham Railway near Berkhampstead.

The kindness of Mr. G. Royde Smith, of Watford, of Mr. J. C. Macgregor, of Calcutta, and of Mr. C. Harvey Combe, of Cobham Park, Surrey, enables me to record the following interesting facts:—

There does not appear to be any place of this name on the route of the L. and B. Railway, "nor any even suggestive, the word 'combe' being hardly ever used in this corner of Hertfordshire."

On the other hand, there lived at Cobham Park, Surrey, Alderman Harvey Christian Combe, sometime Lord Mayor and M.P. for the City of London, who died in 1818. His son, Harvey Combe, "better known socially in the London sporting world, was master of the Berkeley Hunt, which hunted from London to Bath with three packs of hounds. This energy might have made him widely enough known to achieve fame in any sphere."

Now it appears that an "Old Berkeley Coach" still runs in the summer from Rickmansworth to Wendover, and "there is in the neighbourhood to-day an 'Old Berkeley Hunt' public house, with a hunting scene on the signboard."

So there seems to be a complete chain of evidence to suggest that the locomotive first put to work in this district was called after a man who was no doubt looked upon as something of a hero. The year 1835 had not seen the eclipse by railways of the period described so well and graphically by Mr. G. M. Trevelyan recently as "the brief but characteristically English age of the all-worshipped horse . . . with fox-hunters, stage coachmen, and jockeys as ministers to the national enthusiasm for the noblest of animals." We may well suppose that in choosing the name Harvey Combe, the builders and owner of the engine hoped that it might prove as energetic and ubiquitous as the mighty hunter.

Bath, January 7th. J. G. H. WARREN.

CASE-HARDENING.—At a meeting of the Junior Institution of Engineers, held on Friday, January 7th, Mr. Percy J. Haler, A.M.I. Mech. E., read a paper, entitled "Distortion in Heat-treated Case-hardened Carbon Steels." The paper contained much information about the nature of distortion and the reasons for its occurrence, and perhaps its most valuable contents were the facts and figures relating to the distortion of well-known and much-used articles, such as gauges. The paper was accompanied by graphs, some illustrating the results of particular experiments, others intended to be used for reference in determining the allowance for distortion to be made in a part preparatory to case-hardening. Methods of quenching were criticised and Mr. Haler said, further, in answer to a question put in the discussion which followed the paper, that he had come to the conclusion that the ideal arrangement was to have high-pressure sprays and mixing taps in order that the temperature of the quenching liquid could be regulated at different parts of the surface of the article under treatment. Uniformity of result might then be obtained, which would cause a lot of the present difficulties to disappear.

Railway Matters.

ON November 3rd two of the platforms of the new portion of the Central Station in Sydney were opened, and on December 20th the first section of the City Railway was brought into use, viz., from the Central Station to St. James' Station in King-street.

THE judgment of the Railway Rates Tribunal as to the standard charges from the "appointed day" was issued on Friday last, and is referred to at greater length in our Seven Days' Journal page. Copies of the judgment, price 2s. 6d., can be obtained from H.M. Stationery Office.

A YEAR ago the National Union of Railwaymen had nearly two million pounds in hand, but a goodly proportion of that sum has been swallowed up by the general strike and unemployment since. It has now been decided by the Executive Committee to make a levy of threepence per week on the 400,000 members during 1927 in order to replenish the funds.

A PROMINENT Canadian civil engineer, Mr. J. H. E. Secretan, died at Ottawa on December 22nd, at the age of seventy-two years. He was for many years on the staff of the Canadian Pacific Railway, under Sir William Van Horne, and was associated with the construction of the railway. Mr. Secretan subsequently visited the Yukon and wrote several books of a technical and descriptive character which were regarded as authoritative, among them "To Yukon and Back"; "Out West"; and "Canada's Greatest Highway."

THE Ministry of Transport railway statistics for October last have recently been issued as a Stationery Office publication, price 2s. 6d. They show that, compared with the corresponding month of 1925, there was a fall of 12·7 per cent. in the number of passenger journeys and of 11·8 per cent. in passenger fares. Passenger receipts from all sources suffered a decrease of 10 per cent. The set-off against the fewer journeys, in the way of less train mileage, was only 2·9 per cent. The tonnage of coal, coke and patent fuel decreased by 60·3 per cent., which resulted in the tonnage of freight generally being down by 46·1 per cent. Freight receipts were 22·2 per cent. less, but freight train mileage was 24 per cent. less.

A NOTEWORTHY incident occurred at the National Wages Board on January 4th, when it had to consider the action of the Great Western Railway Company in suspending, as a sequal to the general strike, the salary and wages increments due to the officers and men. Mr. J. H. Thomas appealed to Sir Felix Pole that the company should show a spirit of forgiveness, and that, Sir Felix said, it was willing to do. The incident did not end there, as the following day the tables were turned, and Mr. Thomas was asked to show the same spirit in relation to a very old alleged grievance as to the meal times of carters. That matter was not as easily disposed of, but it was agreed that the Wages Board should express an opinion—and not a judgment—on the point.

THE announcement in the newspapers last week that the London, Midland and Scottish Railway Company was laying down water troughs between Carlisle and Glasgow on both the Caledonian and Glasgow and South-Western sections, has inspired the idea in some quarters that long non-stop runs are contemplated. It is safe to say that such is not the case. Water troughs mainly are provided in order to save the time otherwise occupied in taking water at stations. One of the reasons why some companies were slow in adopting that idea was that it was necessary for goods trains to stop in stations for the axle-boxes to be refilled with grease. The adoption of oil-fed axle-boxes has cut out that necessity and paved the way to water troughs eliminating the calls for water.

ACCORDING to the Board of Trade returns the value of the railway material exported during the first ten months of last year was as follows, the corresponding figures for 1925 and 1924 being added in brackets:—Locomotives, £2,832,817 (£2,246,936, £1,597,681); rails, £1,317,374 (£1,614,662, £1,382,674); carriages, £2,310,875 (£1,253,056, £962,108); wagons, £2,522,656 (£2,978,399, £2,839,188); wheels and axles, £387,001 (£498,693, £493,178); chairs and metal sleepers, £624,029 (£842,715, £1,042,222); miscellaneous permanent way, £926,642 (£1,189,943, £947, 812); total permanent way, £3,651,508 (£4,684,404, £4,562,403). The weight of the rails exported was 162,658 tons (172,989 tons, 149,468 tons); and of the chairs and metal sleepers, 64,212 tons (76,259 tons, 83,402 tons). During the month of October locomotives of the total valub of £307,482 were shipped overseas, which included £118,348 for the Argentine and £70,485 for South Africa. During the same month the value of the rails shipped was £29,537—one-fifth of what was sent abroad in October, 1925, and one-third of that in October, 1924. India received £8979; the Argentine, £2575; Australia, £1795; and New Zealand, £1527.

ON September 20th last, when very heavy rain was falling and the sand, as it dropped on the rails was washed away, a tramcar belonging to the Darwen Corporation got out of control when descending Prince's Brow, where the gradient varies from 1 in 10·3 to 14·8. The car attained a high rate of speed, and was derailed at a sharp curve, and two passengers were killed. Major Hall inquired into the accident, and his report, recently issued, says that the circumstances bear a marked resemblance to a number of other accidents which have occurred during recent years, and in which the mechanically-operated slipper brake has been involved. The principal lesson of all those cases was the same—the efficiency of a brake of that type depended mainly upon an application sufficiently hard to control the car being made at the commencement of the gradient when the car was either stationary or the speed very low. The report proceeds to remark that recent improvements in design, particularly of the air-operated brakes, have drawn increasing attention to the power track brake which has many advantages over the hand applied slipper. Major Hall thinks it is worth the serious consideration of any tramway undertaking whose system includes steep hills. Among his recommendations is one that the sand pipes should be re-designed to allow sand to be dropped on the rail as near as possible to the point of contact with the wheel tire.

Notes and Memoranda.

THE Engineer Surveyor-in-Chief, Board of Trade, gives a warning on the use of stopper rods and washers, in defective fire tubes of boilers, in commenting on an accident on board a steam drifter. He says that the fitting of such stoppers should be considered a temporary measure only, and a new tube should always be put in the boiler before the vessel again proceeds to sea. In the case referred to some of the stoppers had undoubtedly been in position for some considerable time. The practice of depending on tube stoppers for a longer time than is absolutely necessary is a bad one, and may lead to accidents such as that reported on.

IN the course of a recent address to the Coventry Engineering Society, Mr. J. F. Kayser gave some of the first particulars published of the super cast cobalt steel magnets which were placed on the market a few months ago. Cast magnets were first made two or three years ago, since when they had been the subject of a great deal of research work. Magnets of that class had now, he said, twice the strength of the first products, and that strength was four times as great as that of the tungsten steel magnets manufactured in this country previous to 1914. Mr. Kayser stated that present-day magnet steels varied in price from £50 per ton to £700 per ton.

THE daily production of petroleum in the Elliott Pool, Nowata County, Okla., was increased by 240 per cent. in less than eighteen months as the result of the application of compressed air, says the United States Bureau of Mines, which has made a study of conditions in that field. The process consists in pumping air or gas into the oil, thereby artificially restoring, in whole or part, the propelling force of the original gas. The average daily production of the pool for eleven weeks before the wells were prepared for air was 48·6 barrels. At the conclusion of the observations made by the Bureau of Mines the average daily production had risen to 165·5 barrels.

IF titanium nitride powder be applied to the surface of foundry moulds and cores, and especially to those employed in the casting of steel, the nitride gives to these surfaces a high resistance to the molten metal so that the moulding sand is prevented from burning into or uniting with the liquid steel. Very little nitride is required, but the facing must be uniform and must completely cover the surface of the mould. The action of the nitride appears, according to F. Bickowsky in *Chemical and Metallurgical Engineering*, to be thus: As the steel cools in the mould the hard nitride gradually oxidises to the soft fluffy dioxide. During the oxidation nitrogen gas is slowly liberated and this gas forms a protecting film between the cooling metal and the air, so that the steel maintains a bright, unscaled surface.

IN the sedimentary formations usually present in oil fields the cutting speed of a diamond bit ranges, according to the American Bureau of Mines, from 6ft. to 15ft. an hour, probably averaging about 10ft. This includes the time necessary to run back the hydraulic gear and take a fresh grip on the drill pipe, but not the time for running in or pulling the pipe out of the hole. The rotary and the diamond drill are both more effective than cable tools in making holes at great depths. The diamond drill cuts as effectively and quickly at great depths as at shallow depths, except for the longer time required to pull and run the drill rods. Observations on drills operating at several different points in the Mid-Continent oil field and in Mexico showed these machines to be cutting at the rate of 8ft. to 12ft. an hour.

AN interesting case of corrosion was described in a paper read before the Institution of Engineers, Australia, by Mr. H. E. Bellamy. In a street in Adelaide, where probably there are no stray electric currents, a piece of 4in. diameter water main was cut out and examined. The pipe had evidently undergone a complete change, as half of its thickness was soft and easily scraped with the nail. Upon examination of the soil in which the pipe had been laid, it was found to consist mostly of clay with crystals of gypsum distributed throughout the clay. The author attributes the corrosion of this particular pipe to local currents set up by the contact between the graphite particles and the iron, in the presence of a solution of calcium sulphate, at the points where the crystals of gypsum were contained in the clay adjacent to the pipe.

THREE rubber-lined pipes each of 9in. internal diameter and length of about 20ft. have been in continuous operation on the discharge line from an 8in. gravel pump at the Sungei Bari Mine, Malaya, for a period ranging from 18 months from the date of installation of the first pipe. These pipes have been subjected to a continuous flow of gravel, amounting to about 17,000 cubic yards of solids per month, and a working pressure of about 17 lb. per square inch. The three pipes, although differing somewhat in design, are all alike regarding the successful results of the rubber applied to them, says the *Industrial Australian*, there being little or no evidence of wear or abrasion on the rubber after this lengthy period of operation. The lining is of crepe rubber about ¼in. thick. The life of a lap-welded mild steel pipe ¼in. thick on the same line, with frequent turning to ensure even wear, does not amount to an average of seven months.

IT has often been claimed, says *British Industries*, that the best free cutting steels have come from America, but if there ever was any justification for this claim it is certainly no longer the case, for a British firm has just put on the market a steel which not only gives better free cutting qualities but at the same time gives much better mechanical results. Exhaustive tests have been made, and the manufacturers are prepared to guarantee that their steel will meet the most exacting requirements. Another notable improvement has been in the manufacture of case-hardening steels. One firm has placed on the market a carburised and refined steel which requires only one heat treatment and a water quench to give a "glass hard" case. It is supplied in bar and strip forms, accurate to size, plus the usual grinding allowance, all surface defects are removed and the "core" is tough and free from slag and "ghost" lines. This new development means a large saving of expense, particularly to large repetition manufacturers of gudgeon pins, test bars, mandrels, broaches, &c.

Miscellanea.

A GREAT pulp and paper mill is to be put up at Prince George, British Columbia, at a cost of about £6,000,000.

IT has been decided to re-equip and restart the Russian Nikitinski mercury mines which had an annual output of 380,000 kilos. of the metal.

FRESH tenders are to be invited for the construction of the double-deck bridge over the Clarence River at Grafton, New South Wales. The approximate cost of the structure is put at £500,000.

THE British Consulate-General in New York has announced that the $10 visa fee on passports to Great Britain will be remitted in favour of American buyers who visit the British Industries Fair in England.

THE new refrigerating plant at Buenos Aires, which was opened on January 4th, by Messrs. Vesty Brothers, of London, is said to be one of the largest in the world. It is capable of dealing with a million and a-half bullocks and two million and a-half sheep annually.

THE Throndon Sea Wall at Wellington, the largest work of its kind in New Zealand, is nearing completion. It will provide a base nearly three-quarters of a mile long, for berths for ocean-going ships. The total length of the wall is 3879ft., and it reclaims an area of 68 acres.

THE annual general meeting of the Institute of Metals will be held in London on March 9th and 10th, and the annual autumn meeting at Derby in September. Arrangements for the latter are being made under the direction of Sir Henry Fowler. Sir Henry has just been appointed a vice-president of the Institute.

THE United States Navy Inspectors made, on January 10th, what is reported to have been a successful test with a new air-cooled aeroplane engine, known as the "Wright Cyclone," which is claimed to be capable of developing 525 H.P. According to a representative of Messrs. Wright, the engine will for the present be used exclusively for United States Army and Navy aeroplanes.

IT is announced that Mr. E. L. Hann has been appointed deputy chairman and managing director of the Powell Duffryn Steam Coal Company, Ltd. Mr. Hann is chairman of the Monmouthshire and South Wales Coal Owners' Association, a member of the Council of the Institution of Mining Engineers and of the South Wales Institute of Engineers, and is also a member of the Board for Mining Examinations.

PROJECTS to dam the water of three lakes in the St. Maurice District have been submitted to the Department of Lands and Forests, Quebec, by the Belgo-Canadian Paper Company. These works will be carried out at the outlet of Lake Kiskissing, at the outlet of Lake Lescarbot and in the Bostonnias River in the same district. Plans have been submitted to the government in accordance with the law.

THE Australian Commonwealth lighthouse service has equipped the lighthouse at Wilson's Promontory and the lighthouses at Deal Island and Cliffy Island, in Bass Strait, with wireless transmitting equipment, so that the two island lighthouses, which are now isolated from the main land, could keep in touch with the lighthouse at Wilson's Promontory, which is connected with Melbourne by land telephone lines.

THE Spanish Cabinet has been considering the issue of a Ministry of Public Works Decree instituting a system of compulsory expropriations with a view to the intensive development of hydro-electric power for industrial purposes. It has further authorised the construction, by private enterprise, of a direct roadway between Madrid and Valencia, 270 kiloms. long, to be exclusively reserved for motor cars. The undertaking will not be subsidised, but the concessionaires will be empowered to levy a toll, approved by the Government, on cars using the roadway.

NINE years will henceforth be the minimum time in which the degree of "Engineer" may be won from Lehigh University, says an official stateiment by President Charles R. Richards, issued recently. Beginning with the entering class next autumn, the usual four-year course will lead to the degree of Bachelor of Science in the various branches of engineering. Five years of acceptable practical experience in responsible charge of work after graduation and the submission of a suitable thesis will be required before the University will stamp a candidate as a full-fledged civil, mechanical, electrical or chemical engineer.

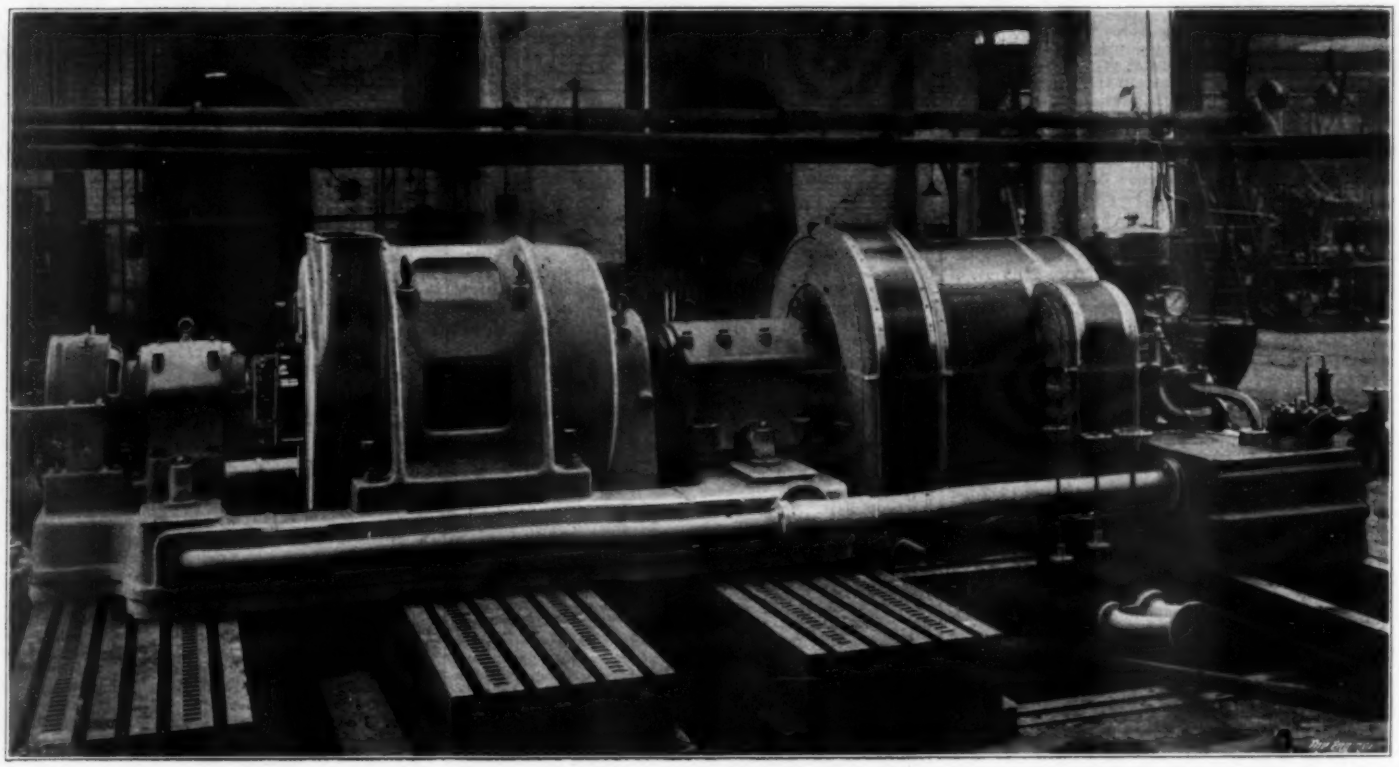
APPLICATION has been made to the Brazilian Congress for a monopolistic concession for the erection of a factory for the chemical treatment of national fibres and the manufacture of rope, sacking, string, &c. It is sought to obtain exemption from import duties for fifteen years, covering machinery, tools, constructional material and chemicals, exemption for fifteen years from all Federal taxes, and a bonus of 33 per cent. on the capital employed in the erection and installation of the factory. Existing factories with a minimum daily capacity of 1 ton would be included in the concession. The State most benefited by the granting of this concession would be Sao Paulo, where over 1,250,000 hectares are now under coffee, and there are four important jute mills, a fifth being contemplated. The consumption of gunny-bags for coffee is estimated at between 6,500,000 and 7,000,000 annually.

ACCORDING to an announcement made by the Ottawa Board of Trade, a new international bridge to cost approximately 6,000,000 dollars, is to be constructed, as a private enterprise, across the St. Lawrence River near Brockville, Ontario. The American end of the structure, according to the plan, is to be at Collin's Landing, three-miles west of Alexandria Bay, N.Y. The bridge will be in three sections. The first one of 650ft. will end on Wellesley Island. Four and one-half miles of motor road across the island will lead to the second section, over what is called the rift and the international boundary to the Canadian part of the island. The third section of 550ft. will run to the Canadian mainland, a little west of Rookport, Ontario. The bridge will be on the route of the projected highway between Ottawa and Washington. The promoters state that the project is sufficiently far advanced to permit of work being started within a month, but the necessary legal formalities may delay operations until the early summer.

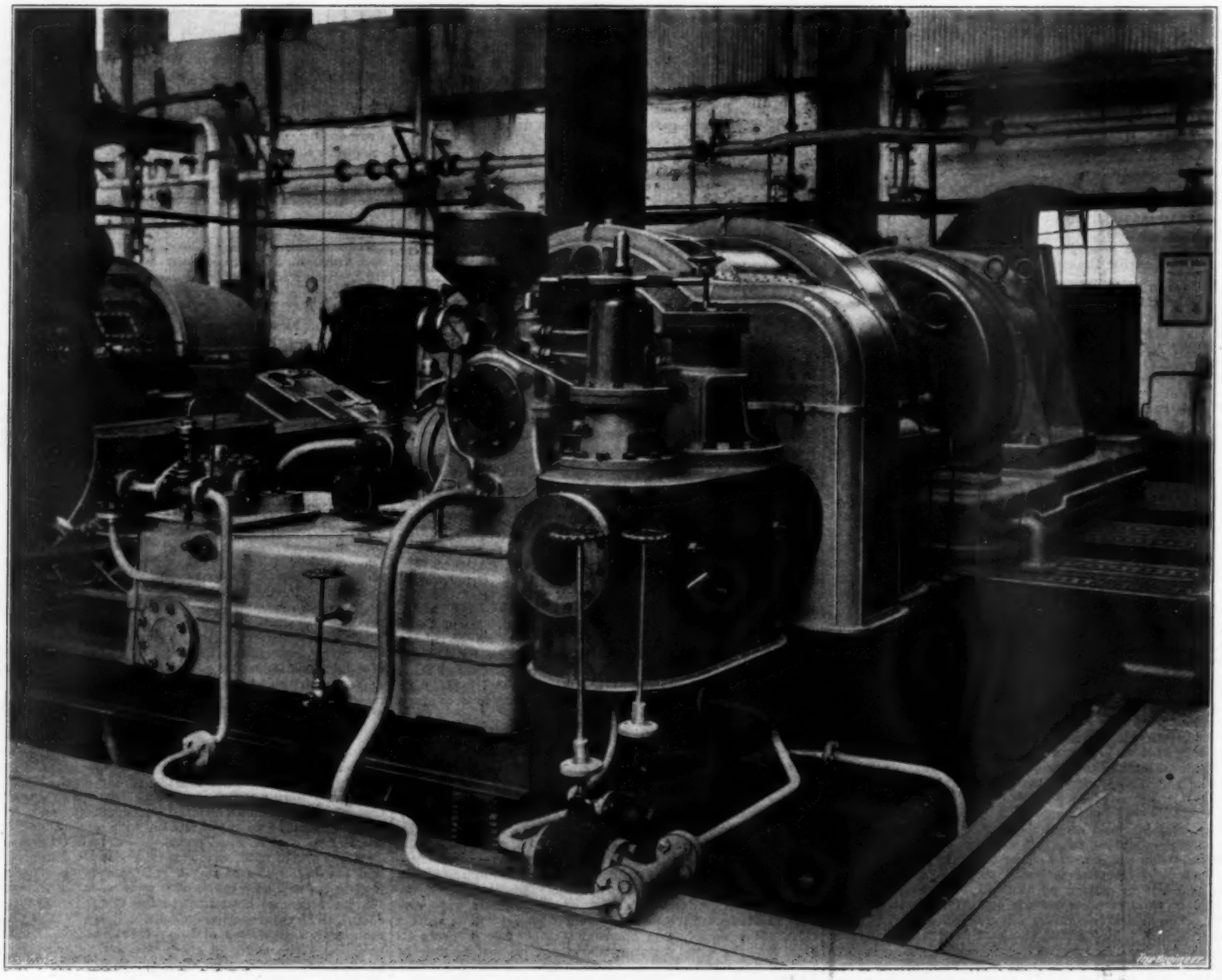
BACK-PRESSURE TURBINE COUPLED TO ALTERNATOR

THE ENGLISH ELECTRIC COMPANY, LTD., LONDON, ENGINEERS

(*For description see page 56*)



GENERAL VIEW OF THE COMBINED SET



VIEW OF TURBINE END, SHOWING GOVERNOR GEAR

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHAVILLET, Rue de la Banque, Paris. CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
GERMANY.—FRITZ REHFUS, Blumenthalstrasse, 10, Cologne.
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THE ENGINEER.

JANUARY 14, 1927.

The Future of the Marine Oil Engine.

WE usually associate the first marked development in the construction of marine oil engines with the year 1920, from which time onwards British shipbuilders and shipowners rapidly gained and have continued to retain year by year the leading world position as constructors and operators of motor-propelled vessels. After seven years of active and varied marine oil engine construction, we see to-day little or no indication of any finality of engine type. It is possible that for many years to come a wide selection of different kinds of marine oil engines will continue to be built and severally applied to the vessels for which they are best suited. An analysis of present practice shows that for ships requiring an engine-output of, say, 4000 I.H.P., the single-acting four-stroke type of motor still predominates, although the two-stroke single-acting engine is increasingly finding favour, especially for higher powered ships. The main trend in recent years has been in the direction of adopting the double-acting principle, in order to reduce machinery weights and to give engines of larger unit output up to 10,000 I.H.P. Even in this comparatively new field of development, the old rivalry between the four-stroke and two-stroke systems is still apparent. For the four-stroke double-acting engine, which still maintains a slight lead in the new field, it is claimed that heat stress conditions—especially with the off-set type of combustion chamber—are less onerous than in the two-stroke double-acting motor. In the latter type of engine, however, the reciprocating parts are used to their fullest advantage, and a considerable saving in weight, which must be also reflected in engine cost, is obtained. With the wide range of power which is given in engines of the small four-stroke single-acting type up to the largest units operating on the double-acting two-stroke principle, the requirements of the small cargo steamer and the largest passenger liner can to-day alike be met. Increased standardisation in manufacture has also brought with it a tendency in the direction of simplicity, but reliability has always been the main consideration. In this connection it would seem as if the question of airless injection and the elimination of the air compressor will in the future receive increased attention.

A recent development which will probably have an important effect on the future of marine engine design is the use of supercharging. It is found that by raising the induction air pressure of a four-stroke engine to 1 lb. or 1½ lb. per square inch above atmosphere, its normal output can be increased by from 15 to 20 per cent. without subjecting the cylinders to undue heat stresses. A paper read by Mr. Robert Love before the Institution of Engineers and Shipbuilders in Scotland on Tuesday, January 11th, deals with this question, and in it some interesting figures are put forward. With a view to testing the possible output to be obtained from an engine of the Beardmore-Tosi single-acting four-stroke type, when supplied with induction air at pressures up to 1·52 lb. above atmosphere, tests were made by William Beardmore, Ltd., on a two-cylinder auxiliary engine, designed for a normal output of 120 B.H.P. at 230 r.p.m. When running at this normal rating without supercharging, the volume of the compressor space in the cylinders was arranged to give a compression pressure of 450 lb. per square inch, corresponding to a maximum or firing pressure of about 530 lb. per square inch. By supplying the engine with forced induction air at a pressure of 1·52 lb. above atmosphere, the compression pressure was raised to 510 lb. per square inch, with a maximum or firing pressure of from 545 lb. to 555 lb. When developing an output of 13 per cent. in excess of its normal rated power, the temperature of the exhaust gases was shown to be slightly lower than that when running under unsupercharged conditions, from which fact it may be deduced that at 15 per cent. excess output, the heat stresses in the engine are not increased. Even at an output of 20 per cent. over the normal rating, the only sign of overloading was, we note, in the colour of the exhaust. It is of interest to learn that when running under supercharged conditions a slightly better fuel consumption was obtained, which was probably caused by the small improvement in mechanical efficiency, and the better combustion, due to the increased weight of air in the cylinder, which, it may be stated, allowed extra fuel to be burned. The experiments referred to would seem to show that although the compression pressure in the cylinder is increased, the maximum or firing pressure does not increase in the same ratio, and that by making a suitable adjustment to the final injection timing gear, the rise in the final pressure can be restricted to the usual working limits. The result obtained may be very simply described as a process whereby the area of the indicator card is enlarged without increasing its height. In order to supply induction air at a higher pressure it is necessary to utilise a turbo-blower, but the power to drive it is relatively small, and can readily be obtained from the heat in the exhaust gases, either by their direct expansion in an exhaust gas turbine coupled direct to the blower or by a steam turbine supplied with steam raised in an exhaust gas boiler. In either case the arrangement is a most convenient one, for the supercharging is only required when the engine is working at three-quarters to full load, under which conditions there is more than enough heat available for recovery from the exhaust gases. Mr. Love also showed that by adopting supercharging the number and size of the engine cylinders could be reduced, with a corresponding gain in space and weight. These advantages are also well marked when hydro-mechanical gearing is employed to combine two engines on a single propeller shaft. The latter part of Mr. Love's paper is taken up with a description of the new twin three-cylinder Beardmore-Tosi double-acting four-stroke engines fitted to the converted steamer Wulsty Castle, and arranged to drive the single screw through hydro-mechanical clutches and reduction gearing. We would congratulate William Beardmore and Co., Ltd., on the very frank way in which they have allowed Mr. Love to give full details of the maiden voyage of the ship. It is to be regretted that in ballast condition the vessel was so light on her outward voyage from the Clyde to Galveston that in bad weather met in the Atlantic the engines raced, and two cylinder heads and one exhaust pipe were damaged, as a result of the unsatisfactory working of the engine-driven cooling water circulating pumps. That the engines did so well on the return voyage when one cylinder head was out of action, owing to the cause above mentioned, is also a matter for which the designers of this new type of engine deserve credit.

Although three large British-owned ships were fitted with supercharging arrangements last year, the idea emanated from the Continent, where most of the early experimental work was done. We would venture to suggest that if marine oil engine builders had followed more closely the research work and recorded practice of British gas and oil engine builders, much time might have been saved and progress helped forward. The subject of scavenging has been carefully studied in connection with land engines, and another interesting phenomenon connected with gas engine work which we may perhaps mention is the scavenging effect

to be obtained by the pulsation of a column of exhaust gas in a long pipe, a practice which may yet be turned to marine use, and was recently referred to by Mr. D. M. Shannon as a possible field for re-exploration. There are many aspects of marine oil engine design and running practice which, were they to be openly discussed by builders and users of motor ship machinery, would, we are convinced, materially help forward the industry. In the early days of marine oil engine development the performances of motor ships at sea were hedged round with impenetrable mystery. Much of that conservatism still remains to-day, although we believe that among associated shipping companies it is now the practice for the superintendent engineers to confer together on matters of ship performance, repairs, &c. Surely it would not be difficult to widen this circle of discussion so as to include within it those who build the engines and those who run them. We should like to see, say, for example, in the ports of Belfast, Glasgow, Liverpool, Newcastle and London, keen groups of marine oil engine builders and users meeting, perhaps under the auspices of one of the institutions or societies, in order to discuss problems connected with the design and running of motor-propelled vessels. The publication and discussion of the service performance of various types of marine oil engines cannot fail to do other than help to remove any difficulties still outstanding, as well as to give confidence to those who are called upon to operate the machinery at sea, and to those on whom the responsibility for new designs falls. It is by such closer co-operation of all engineers engaged in this yet young and most important branch of marine engineering that the future success of the British marine oil engine will be made certain.

Coal Ash and Probability.

OF the various items included in a proximate analysis of coal, the percentage of ash is the one which is generally regarded as the most trustworthy. The figures given for the other constituents, namely moisture, volatile matter and fixed carbon, are all much more liable to be influenced by the methods or the judgment of the person who makes the analysis. There is something tangible and definite about ash. It is a simple matter to burn a sample of coal in a crucible till it will burn no more, and then to determine with accuracy the weight of the incombustible residue which remains. This residue, whatever it may be composed of, is ash to the mind of the engineer, and constituting as it does an expensive and at times an almost intolerable nuisance, the extent to which it is present in any consignment of coal is of great practical importance. The value of coal to the user is, in fact, very largely a function of its ash content. Hence both for this reason and for the confidence which may be placed in determinations of ash, the figures for ash content are closely watched by buyers. It is, however, one thing to believe the results of an analysis, and another to believe that the percentage of ash found in the sample will be the same as the average percentage of ash in the consignment from which the sample was taken. The gramme or so of fuel actually tested in the laboratory is only about one five-millionth part of the quantity a fair-sized boiler will burn in an hour, and however great the care taken in sampling, it requires an effort of faith to feel sure that a selected pinch of coal will certainly represent the average composition of a quantity many million times as great. Indeed, one can never feel quite sure. The bulk may or may not be epitomised in a sample, and the frequency with which it is not, is shown by the rareness of agreement between the analyses of several samples taken from the same bulk. As, then, we have no certainty that the bulk possesses the same characteristics as the sample, we have no other guide for our actions than our judgment as to the probability that it does so. The value of this probability cannot be expressed in figures. It depends on our previous knowledge of similar coal, our confidence in the way the sample was taken, and upon other numerous and imponderable reasons which tend to credit or discredit the results of the analysis.

There is, however, another kind of probability which is amenable to figures. By inverting the usual order of thought, and imagining the average ash content of the consignment of coal to be known, we can calculate the probability that a sample will fairly represent the bulk. A sample is nothing but a large but finite number of particles, and if we suppose these particles to have been collected one by one at random from the bulk, the result will obviously be as perfect a sample as could possibly be obtained. If, for example, the bulk contained 12 per cent. of ash—or, more properly, ash-making material—we should expect twelve out of every hundred of the particles collected to be particles of ash, assuming for the sake of simplicity that particles of coal and ash have the same weight. Were this proportion to be exactly obtained, the sample would be truly representative of the bulk, in so far as ash was concerned. But there is clearly a considerable chance that the number of ash particles collected will be either less or more than the exact number required to constitute in the aggregate 12 per cent. of the sample. The probability of any particular number of ash particles being included in the sample can be easily calculated. It is a case of the old school-book problem of determining the probability of a certain number of successes in a given number of events, supposing the probability of the success in a single event to be known. Every particle in the sample can be considered an "event," and every time a particle of ash is taken, it may be counted as a "success." Furthermore, the probability of a single success is, of course, equal to the percentage of ash in the coal. To get an arithmetical result, it is necessary to postulate the number of particles in the sample. Supposing, for example, that a sample weighing 1 gramme is made up of a thousand particles, each weighing a milligramme, and that the probability of any single particle being ash is 12 per cent., we should expect to find 120 milligrammes of ash in the sample. This would indeed be the predominant figure, if a large number of samples were examined, but the probability of exactly 120 milligrammes of ash being found in a given sample is actually only about 3·8 per cent. So small a chance is perhaps a little astonishing at first sight, but it must be remembered that there are no less than a thousand and one different compositions possible for the sample in question, ranging between the highly improbable limits of all pure ash and all pure coal. If, then, under the conditions assumed, we have less than four chances in a hundred of having the same percentage of ash in the sample that the bulk is known to contain, it is hardly surprising that an analysis cannot always be depended on. A difference of 10 milligrammes of ash in the sample, being equal to a variation of 8·5 per cent. from the composition of the bulk coal, would be considered an appreciable error, yet the chances of the sample containing either 110 or 130 milligrammes of ash are quite three-fifths as good as that of exactly 120 milligrammes being present. Outside these limits the chances of any particular ash percentage fall off very rapidly, the probability of the sample containing 100 or 140 milligrammes being of the order of one-half of 1 per cent.

It may be objected that the kind of sample we have assumed, namely, one composed of 1000 separate milligrammes, has little relation to actual practice, as a gramme of coal pulverised ready for an ash test may contain several million particles. This is true, but although the magnitude of the figures may be altered, the validity of the reasoning is unaffected. We took a milligramme as unit because it served as well as any other to illustrate the principle, and was, moreover, the smallest difference of weight taken account of with the apparatus ordinarily used for coal testing. With a sample consisting of particles less than a milligramme, and a balance correspondingly sensitive, the probability of an exact agreement between the composition of the sample and that of the bulk is, of course, very much smaller, for in such a case the number of possible constitutions of the sample is increased in proportion to the smallness of the particles. It is, however, easy to take into account the effect of smaller particles, while keeping to 1 milligramme as the unit of weight, by the summation of the separate probabilities over the interval assumed. It is equally easy to allow for the different densities of ash and coal, and so arrive at a more or less exact solution of the problem. The work, however, is tedious, and the figures involved become of almost astronomical magnitude. The general result of all calculations of this kind is to emphasise the smallness of the probability that a sample will have exactly the same percentage composition as the bulk from which it is taken. There is also another point of some interest. The probability that a sample will resemble the bulk is not the same for all percentages of ash in the bulk. The higher the ash content, up to 50 per cent., the less this probability becomes. If the bulk contains 5 per cent. of ash, the chance of finding the 50 milligrammes required to make a sample weighing a gramme conform to the consignment would be about 5·7 per cent., whereas with a bulk containing 20 per cent. of ash, the probability of finding the same percentage of ash in the sample would be little more than 3 per cent. It would be well if some responsible body would determine, by statistical methods, the "probable error" of standard practice in coal sampling, and also, by the application of similar methods, the "probable error" of an analysis by a competent chemist. In the report of the Fuel Research Board for the year 1925, which has only just been issued, it is stated that "the conclusion was recently reached that a still further investigation of the question of the sampling of consignments of coal . . . was desirable before the issuing of any report, and, in order to expedite the work, a special sub-committee on Sampling has been formed." The report adds: "It is, therefore, hoped that it will be possible, in the near future, to formulate and publish recommendations in regard to this difficult and urgent question of the sampling of coal." The word "recently" is now many months old, for the sub-committee was, as a matter of fact, constituted in 1925. It has, we believe, done little or nothing so far—the coal stoppage must be sufficient excuse—but we venture to hope that since it itself recognises the urgency of the problem, it will take steps to pursue the investigation at an early date.

SIXTY YEARS AGO.

SIXTY years ago, as we may gather from various pieces of information published in our issue of January 11th, 1867, the country was in the grip of very severe weather. A night switchman on the Great Western Railway was found frozen to such an extent that he died two days later. The streets of London were rendered impassable to horse-drawn traffic, and the people seeking transport flocked on to the Metropolitan Railway, the traffic on which reached, it is recorded, "a most extraordinary scale." Invaluable relief, too, was afforded by the newly opened South-Eastern line between Charing Cross and Cannon-street. In the country severe snowstorms greatly impeded or stopped all locomotion. The railway from Holyhead to Chester was completely blocked. Men were sent out to clear the line, but the snow drifted faster than they could remove it, and they had to give up the task as hopeless. A train from London to Salisbury ran into a snow drift between Grately and Porton, and there it remained for nearly twelve hours despite "the most vigorous and persevering efforts to extricate it." A heavy drift of snow on the line between Bangor and Leeds led to a very serious accident near Aber. The drift caused the engines drawing a night train to be derailed. Carrying a Post Office carriage with them, they broke away from the rest of the train and rolled over down an embankment. By a miracle no lives were lost, but the travellers would appear to have spent a trying time. The severity and wildness of the night were such that no help could be sent to them until dawn, when gangs of men were employed to clear away the snow that had blocked the lines. The severe frost was, it was suggested, responsible for another railway accident which occurred about the same time. A north-bound express was near Althwaite when an axle of a third-class carriage snapped, probably as a result of the low temperature. The carriage was smashed and several others were overthrown, but no one received other than slight injuries. Possibly, too, the weather may have been the cause of yet another accident. Two Manchester express goods trains left Grantham within ten minutes of one another. At Newark the first stopped to take in water. The second, although warned of the precedence of the first, overtook and dashed into its rear, smashing and overturning the trucks and completely blocking both lines. None of the staff on either train suffered more than a severe shaking. Finally, the overloaded condition of the Metropolitan railway may have been the cause of a collision between two trains at Farringdon-road Station, although the official explanation was the inefficiency of the brake power on one of the trains. All these mishaps and misadventures occurred within the space of two days.

BOOKS RECEIVED.

High Vacua. By G. W. C. Kaye. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 10s. 6d. net.

Industrial Combination in England. By P. Fitzgerald. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

The Concrete Year Book, 1927. Edited by O. Faber and H. L. Childe. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W. 1. Price 2s. 6d. net.

Lubrication in Colliery Practice. By N. Simpkin and A. Dawe. London: The Colliery Guardian Company, Ltd., 30, Furnival-street, E.C. 4. Price 10s. net.

Proceedings of the Optical Convention, 1926. Parts I. and II. London: The Optical Convention, 1, Lowther-gardens, Exhibition-road, S.W. 7. Price £3 net.

Electric Telpherage. By G. W. Grossmith. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

The Colliery Manager's Pocket-book, 1927. Edited by J. V. Elsden and H. Greenwell. London: The Colliery Guardian Company, Ltd., 30, Furnival-street, E.C. 4.

Stresses in Space Frames. By Dr. W. W. Padfield. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

Obituary.

SIR FRANCIS FOX.

THE engineering profession has lost a very eminent member by the death of Sir Francis Fox, which took place on Friday last at his home at Wimbledon.

Francis Fox, who was the son of the late Sir Charles Fox and younger brother of the late Sir Douglas Fox, was born in 1844, and was therefore in his eighty-third year at the time of his death. His father was himself an engineer of high standing, though, as a matter of fact, he had, as a youth, intended to become a doctor. As it was, he became famous as the constructor of railways, but perhaps even more famous as the builder, to the designs of Joseph Paxton, of the enormous building which housed the famous Exhibition of 1851, and was subsequently removed to Sydenham Hill. As quite a small boy, in the company and charge of his elder brother, young Francis, who was not then seven years old, used nearly every day to visit the site of the works during the time they were in progress, and there, on many occasions, he met the Duke of Wellington, who was most enthusiastic concerning, and a thorough believer in the ultimate success of, that glazed building of unusual type and giant size, which many people foretold must turn out to be a failure. In his book, "Sixty-three Years of Engineering," which was published in 1924, and from which much of the information contained in this memoir has been derived, Sir Francis tells how, on one occasion, the "Iron Duke" was talking to his father, when the latter was called away. As he left, he requested the victor of Waterloo "to look after my boys that they do not get into danger from the machinery." So efficiently did the old soldier hold the hands of those youngsters that they had no chance of escaping. Just before the opening of the Exhibition Charles Fox had to go to Paris on business in connection with it, and he took the lad Francis with him. They were accompanied by Mr. Thomas Brassey, the contractor for the Paris–Rouen railway, and Mr. Paxton. While in Paris they visited the studio of Monsieur Daguerre, who, as all the world knows, was one of the famous pioneers of photography. It is worthy of note in passing that the span of Sir Francis' life very nearly extended over the whole period covering the discovery and development of photography. It can, at any rate, be said that, when he was born, photography as it now exists was not known, and had not been even dreamt of. Incidentally, too, it may be remarked that during his life practically the whole development of electricity as a factor in commercial and domestic life was effected.

Apart from the excitement of visiting the growing "Crystal Palace," the life of young Francis Fox and his brother must have been full of interest. Faraday was a personal friend of the family, and his Christmas lectures were "great events" in the lives of the children. Then, too, "The Polytechnic," under Dr. Pepper, was perhaps at its zenith, and was evidently highly appreciated. Then, again, there was the Diorama in Regent's Park. To all these attractions Sir Francis refers in his book from which we are quoting, and there is no mistaking the pleasurable impressions they left on his mind. Many things were happening at that time, too. The Crimean War began when Francis was only ten years old. Scott Russell constructed the first submarine—a vessel primarily designed for reducing the fortress of Kronstadt—and the lad saw it in the Thames. He saw, too, the Great Eastern "being slowly launched sideways" at Millwall, and he witnessed the testing at Sheerness of the "iron-plated" steam frigate Warrior, of 6170 tons, at that time, with the exception of the Great Eastern, the largest vessel afloat. In fact, he grew up in an atmosphere of engineering and scientific subjects just when both were beginning to take great strides forward. It is no wonder, then, that he followed in his father's footsteps and chose engineering for his profession.

It was his father's intention that both his sons should go to Cambridge before joining him in his office, and their names had actually been entered on the books of Trinity College. An accident, however, entirely altered the trend of affairs. Sir Charles was one evening walking along the esplanade of a seaside watering-place, unaware that the tide had washed away part of it. The spot was evidently not lighted, and not seeing the gap he stepped into it and fell a considerable distance on to fractured masonry. He was, as may well be imagined, much injured, but though he recovered and survived the fall for some thirteen years, he was, never after, the same man, and the immediate result was that his two sons, instead of going to the University, at once joined him in business, the title of the firm being Sir Charles Fox and Sons. Francis, with a view to making up in some measure for the loss of the training at Cambridge, attended the lectures of Professor Tyndall, Dr. Miller and other leading men of the day. His studies included work in mechanical shops, where he learnt the use of tools, turning, patternmaking, smithing and forging, besides civil and mechanical engineering. He also studied chemistry with Dr. Stead, F.R.S., of Middlesbrough.

"Sixty-three years ago I began work with my father, the late Sir Charles Fox, and my brother, the late Sir Douglas Fox." Thus wrote Sir Francis in 1924. Sixty-three years is a long stretch of time, yet, during the whole of it Sir Francis was kept continuously busy, and was engaged on works, many of which are historic. It would be impossible, in the space at our disposal, to refer, even briefly, to all the undertakings with which he was concerned during his long career, and it must suffice to mention a few of them. Among the first great engineering works in which he took part was the duplication of the Victoria railway bridge at Pimlico, when he acted as assistant to Mr. Edmund Wragge, the resident engineer on Sir Charles Fox's staff. The work of which this bridge formed part occupied three years, from 1864 to 1867, to carry out, and in it Francis Fox had a full share. One of the most difficult, as well as the most interesting things that had to be done was to set out the exact length of the spans or openings across the river. In writing of this portion of the undertaking, Sir Francis said: "We had to do this, high above low-water level, with accurately marked rods, 20ft. in length, on a single baulk of timber, 12in. in width, on which was fixed one of the iron rails for moving forward travelling cranes. There was therefore no hand-rail, and only just 5in. width on each side for foothold at a height of 50ft. above the water. With passing steamers and barges it was difficult enough to keep one's head and maintain one's balance; but the danger was increased because each of us at the end of the 20ft. rod had to kneel down on the baulk, make the necessary mark, then get up and repeat the operation at each length of the rod, all the way across."

The next few years of his life Francis Fox spent in London, and during three of them—1867–1870—he and his brother Douglas were officers in the London Rifle Brigade. In 1870 he made what was at first an unsuccessful attempt to get the London Omnibus Company to fit brakes to their vehicles, so as to ease the sufferings of the horses going down hills, which, as a youth and young man, he had witnessed and deplored. Apparently, at that time, there were no brakes at all employed. He went so far as to acquire shares in the company, so that he could attend one of its meetings, and to get from a well-known omnibus builder a quotation to fit suitable brakes at £5 per vehicle. His suggestion was at the time definitely refused, but his efforts bore fruit. "Within a few months," he tells us, "brakes began to be fitted, the harness was simplified, and in a comparatively short time there was not a brakeless bus in London."

In 1872 we find him filling quite another post. He was made manager of an ironworks in the North of England. Then in 1880 he began his connection with the Mersey Tunnel, of which Sir James Brunless, his brother Douglas and he were joint engineers. The length of tunnel actually under the Mersey is 1320 yards, and, between the pumping shafts in Liverpool on the east bank and Birkenhead on the west, 1770 yards. A shaft 15ft. in diameter and 170ft. deep was sunk at each end of the tunnel, and, as they passed through the beds and fissures of the New Red Sandstone they were very wet. Much water was also met with in driving the drainage headings and the main tunnel. At one period it was necessary to pump as much as from 8000 to 9000 gallons per minute, or at the rate of 11½ to 13 million gallons per day from the shaft. Even at the day of opening in 1886 some 7000 gallons per minute were being pumped, but by 1919 the volume had fallen to 6000 gallons. The tunnel was driven by hand from the Liverpool side and from the Birkenhead side by means of a machine invented by Colonel Beaumont, R.E. The average rate of progress throughout the length of the tunnel was 9 yards per week.

SIR FRANCIS FOX

Mr. Fox's first connection with the Manchester, Sheffield and Lincolnshire Railway—later the Great Central—was on August 15th, 1882, when he received a letter from the chairman of the line asking him to call on him. He went, and was received by the chairman in the following somewhat peculiar manner:—"I want you to build a railway; there are the plans"—pointing to a large roll. "Take them away, and don't let me see them again till the railway is ready for opening." Thus began a connection which lasted some twenty years. One of the first works to be undertaken was a swing bridge over the river Dee, a few miles below Chester. For the central support for this bridge a cylinder consisting of a circular wall of brickwork in cement, 43ft. in diameter, 5ft. thick, with a steel cutting edge at the bottom, was employed. While it was being sunk a heavy flood occurred in the river, and the cylinder tilted over some 5ft. It weighed 2500 tons, and to the chairman of the company, who happened to visit the works on the day of the occurrence, it seemed impossible that it could be righted. However, by the use of a powerful jet of water projected through a 2in. nozzle on to the ground below the cutting edge, the cylinder was brought back to within ⅛in. of its desired position in a few hours.

In 1894 it was decided to extend the Great Central to London, and Mr. Fox was entrusted by Lord Wharncliffe, who had just been made chairman of the company, with the work of superintending the construction of the portion of the line between Rugby and London. The first sod was cut on November 13th, 1894, and the railway was opened for public traffic on March 9th, 1899. In the formation of the Marylebone terminus alone 1000 houses had to be demolished.

The construction of the Liverpool Overhead Railway was carried out between 1887 and 1893. The engineers were Sir Douglas Fox and Mr. J. H. Greathead, Mr. S. B. Cottrell and Mr. Francis Fox being in charge of the works. The next work on which the subject of this memoir was engaged was the design and construction of the Snowdon Rack Railway between 1894 and 1896. For this purpose he made a special visit to Switzerland to study the various systems of rack railway in use there.

Sir Douglas Fox and his brother's connection with the tube railways of London extended between the years 1893 and 1907, and at first they were joint engineers with Mr. Greathead—the inventor of the shield bearing his name, which is now so universally employed—until the latter's premature death. The lines with which they were particularly identified were the Great Northern and City and the Charing

Cross, Golders Green and Highgate. In the construction of these lines the grouting machine, of which we shall say more later, was employed many thousands of times with complete success.

About this time Mr. Fox was honoured by being appointed one of three of a "Commission of Experts" nominated at the request of the Swiss Confederation by the Governments of Italy, Austria and England, to examine and report upon the programme and proposals for the driving of the Simplon tunnels. The other members of the Commission were the Hon. Giuseppe Colombo, member of the Senate and afterwards Minister of the Treasury, appointed by Italy, and Herr C. J. Wagner, Chief Government Inspector of Railways in Vienna, and the celebrated engineer of the Arlberg Tunnel, appointed by Austria. The Commission presented its report in July, 1894.

Between 1895 and 1905 the brothers Fox were engaged in railway construction in South Africa, including the line to Buluwayo, and they had a large share in the design and creation of the celebrated Victoria Falls Bridge over the Zambesi. In the building of the latter, Mr. Francis Fox's son, Mr. Charles Beresford Fox, very nearly lost his life. Another engineering work in which both Sir Douglas and Sir Francis Fox were keenly interested was the proposed Channel Tunnel, and both worked hard, though ineffectually, to turn proposal into actuality. Had construction been sanctioned, they would have had charge of the work on this side of the Channel.

Important as Sir Francis' work was in other directions, it is possible that he was most widely known in connection with the preservation of ancient buildings. His first association with work of this nature was when, in 1897, he was asked to inspect and report on Peterborough Cathedral, in the fabric of which some alarming cracks had developed. It was with Winchester Cathedral, however, that he achieved his greatest fame. The work lasted some seven years, 1905–1912, and it was of a most arduous character. The cathedral was built on a meagre foundation of wood and short wood piles, none more than 5ft. or 6ft. long, on a layer of marly clay, 6ft. deep—the surface of which coincided with the standing subsoil water level—overlying an 8ft. 6in. bed of peat, which was bottomed by a thin layer of quicksand or silt on a substratum of gravel or flints.

"The problem of strengthening the foundations was, therefore," to use Sir Francis' own words, "a very formidable one. . . . Pumping was impossible; compressed air could not be used; screw piles and caissons were considered and rejected; nor could the cathedral be floated (as was at one time proposed) upon a vast slab of concrete, such a slab would almost certainly have cracked." To give in detail the whole of the work carried out is, here, impossible. We can but recite the sequence of remedial measures decided upon. They were:—

(1) Shoring the outside of the building;
(2) Centring the arched vaulting of the interior to prevent collapse;
(3) Putting in steel tie-rods where they were absolutely necessary;
(4) Grouting with liquid cement under compressed air every portion of the walls into which grout could be forced, commencing at the base; and lastly
(5) Underpinning the walls down to the bed of gravel.

It was not till after he had examined and rejected every other possible means, that underpinning by divers was the method adopted. Mr. Fox, who was accustomed to using diver's dress, had a short length of excavation made, and himself went down into the water. To see anything was impossible, for the peat and soil had so stained and made the water opaque that no eye could pierce it; everything had to be done by feel. Even powerful electric light was useless. But, by feel, he ascertained that beneath the thin layer of quicksand was hard flinty gravel, which was quite excellent for foundation purposes; indeed, as it overlay the chalk no better foundation could be either secured or desired. So the work of underpinning began, and it should be put on record that the whole work was, in a period of 5½ years, carried out single-handed and entirely by "feel," by one man, the late W. A. Walker, who was, we believe, one of the expert divers of Siebe, Gorman and Co., Ltd. We cannot spare space to go further into particulars, but must content ourselves by saying that the whole work was a great success, and that it was, we believe, as a recognition of his services in saving the magnificent building at Winchester that Sir Francis received the honour of knighthood. Nor can we do more than say that he was consulted in connection with Canterbury, Exeter and Lincoln Cathedrals, in all of which his recommendations were successful.

The valuable work which he did in connection with St. Paul's Cathedral will be remembered by our readers. He was also called in to advise concerning cracking which had developed in the structure of St. Sophia at Constantinople, but the war intervened and prevented his recommendations being carried out.

As was said earlier, Sir Francis was a great believer in the grouting machine, originally invented by Mr. Greathead, and he employed it with universal success in many directions, notably in repairing churches at Corhampton; Bletsoe, near Bedford; Bishophill Junior, York; Ashbourne; and Ford End. Also for Portinscale Bridge, Derwentwater, and Old Mill Bridge, Oxenholme. An operation of which he was justifiably proud, and which he carried out as the work of a friend, was the restoration of the nurses' home attached to the Hospital for Sick Children in Great Ormond-street. That building, which was some 250 years old, had been condemned as a dangerous structure. Sir Francis managed to get the surveyor to postpone the order for demolition for a fortnight, and in that time, partly by the use of the grouting machine, he had saved the structure and made it perfectly secure.

We have been able only very briefly to outline the career of Sir Francis. There is much that he did that has had, perforce, to be omitted, but enough has been said to show that his life was one long useful endeavour.

HENRY PERCY BOULNOIS.

WE regret to have to announce the death of Mr. Henry Percy Boulnois, which took place in London on the 9th inst.

Mr. Boulnois was born in London on January 15th, 1846, and he had therefore all but completed his eighty-first year at the time of his death. He received his early education at Pocklington Grammar School and went from there to King's College, London. His first practical experience of engineering was gained on the Vendée Railway, in connection with which he worked as assistant engineer. Subsequently, he was articled to Sir Joseph Bazalgette, the Chief Engineer of the Metropolitan Board of Works. At the termination of his articles he obtained the post of District Engineer in Jamaica, where he remained for two years, when he was forced to resign on account of ill-health.

On his return to this country Mr. Boulnois acted successively as City Surveyor at Exeter from 1874 to 1883; Borough Engineer at Portsmouth from 1883 to 1890; and, finally, in 1890, City Engineer at Liverpool, remaining there for seven years. In these positions he carried out many works in connection with sewerage, water supply, refuse destruction, road construction and bridge building. It is said that he was the first waterworks engineer to scrape the inside of a water main to remove incrustation while the main was actually in service. That was while he was at Exeter.

After leaving Liverpool he was appointed an Engineering Inspector at the Local Government Board and had become, when he retired in 1911, Deputy-Chief Engineering Inspector. Thereafter, he carried on private practice as a consulting engineer.

Mr. Boulnois was a member of the Institution of Civil Engineers, Past-President of the Institution of Municipal and County Engineers, Past-President of the Liverpool Engineering Society, and Chairman of Council of the Roads Improvement Association. He was, in fact, a recognised authority on road construction, and was a member of the Advisory Committee of the Road Board. He was the author of "The Municipal and Sanitary Engineers' Handbook"; "Modern Roads"; "A Glossary of Road Terms"; "Reminiscences of a Municipal Engineer"; and "Housing of the Working Classes."

ERNEST FIANDER ETCHELLS.

The death, at the early age of fifty, of Mr. Ernest Fiander Etchells, President, for the current year, of the British Section of La Société des Ingénieurs Civils de France, is announced.

Mr. Etchells, who was the son of Mr. E. F. Etchells, of Romiley, Cheshire, received his education at the Old Andersonian College, Glasgow; Royal Technical College, Glasgow; College of Technology, Manchester; and Kings College and University College, London. He obtained his engineering experience, first as a pupil of Mr. Francis Lawrence Lane, of Leeds, and subsequently in the service of Mr. John Strain, of Glasgow. After being for some time engaged in the design of rolling stock for the Pretoria and Pietermaritzburg Railway, aerial ropeways in Bolivia, and nitrate plants in Chile, he turned his attention to building construction to which he was, events proved, to devote nearly all the remainder of his career. First he was in charge of the structural steel work for the rebuilding of the Lanarkshire Steel Works at Motherwell, and then carried out similar work in connection with the Clyde Valley and the Mexico Electricity Supply schemes. Thereafter he was engaged in the design and carrying out of structural work in all materials, including steel and reinforced concrete. In 1902 he was made an official structural engineer and surveyor in the department of the Superintending Architect of Metropolitan Buildings, with his office in the architect's department in the London County Hall.

Mr. Etchells belonged to many technical societies. He was President of the Concrete Institute from 1920 to 1922, subsequently becoming President of the Institution of Structural Engineers when that body succeeded the Concrete Institute, and was President of the Association of Architects, Surveyors and Technical Assistants in 1925. He was an associate member of the Institutions of Civil and Mechanical Engineers; a member of the Mathematical Society; a fellow of the Institute of Physics and of King's College Engineering Society; and an honorary A.R.I.B.A. In 1922 he was made an advisory member of the Board of Architectural Education, and in 1923 Superintending Examiner of the Institution of Structural Engineers. He was also, in 1924, made a member of the Grand Committee for the International Congress on Architectural Education.

FREDERICK REGINALD PHIPPS.

THE keenest regret has been caused at the Ministry of Transport by the sudden and unexpected death from heart collapse last Sunday morning, 9th inst., of Frederick Reginald Phipps, A.M. Inst. C.E., F.S.I., the Senior Engineering Inspector of the Roads Department.

Mr. Phipps, who was born on March 7th, 1875, was educated at the Bedford Modern School and at King Edwards School, Birmingham. In 1893 he became pupil and assistant to the Borough Surveyor of Tewkesbury and in 1897 he was appointed engineering assistant to the City Engineer of Worcester. From 1903 to 1917 he held office as Borough Engineer at Basingstoke. During the Great War he served under Sir Henry Maybury as O.C. 311th Road Construction Company R.E., subsequently being promoted to D.A.D. Roads, XVth Corps, holding rank as Major R.E., and being awarded the O.B.E. Upon the establishment of the Ministry of Transport in 1920, Mr. Phipps was selected as one of the Engineering Inspectors, and in December, 1924, was advanced to the post of Senior Engineering Inspector, which appointment he held to the time of his death.

SIR ALFRED SEALE HASLAM.

JUST as we go to press we hear with regret of the death of Sir Alfred Seale Haslam, which took place yesterday in London. Sir Alfred was the chief proprietor of the Haslam Foundry and Engineering Company, Ltd., of Derby.

The Quarterly Shipbuilding Returns.

LLOYD'S Register Shipbuilding Returns for the quarter ended December 31st, show that the tonnage under construction in Great Britain and Ireland—760,084 tons—was 14,713 tons less than at the end of September, 1926, and about 125,000 tons less than the tonnage being built twelve months ago. The tonnage on which work was suspended at the end of December, 1926, amounted to 99,468 tons, which was about 2000 tons more than at the end of December, 1925. The present totals are the lowest recorded since June, 1909, and are 1,130,000 tons below the average tonnage being built during the twelve months immediately preceding the war, *i.e.*, 1,890,000 tons. A large increase is shown in the tonnage commenced during the quarter, namely:—152,404 tons, as compared with 68,327 tons during the third quarter of 1926. The tonnage launched during the quarter—67,853 tons—showed the enormous reduction of 139,888 tons, as compared with the figures for the previous three months.

The total merchant tonnage being built in other countries—1,172,943 tons—is about 97,000 tons more than at the end of September, 1926. The tonnage under construction abroad exceeds by no less than 412,859 tons the tonnage being built in Great Britain and Ireland. The figures for the leading countries abroad are:—Italy, 239,776 tons; Germany, 211,062 tons; United States, 151,635 tons; Holland, 145,005 tons; and France, 143,068 tons. From one of the tables we see that 271,237 tons were commenced abroad and 342,423 tons were launched, an increase, as compared with the previous quarter, of 71,210 tons in the tonnage commenced, and an increase of 163,602 tons in the tonnage launched.

The total world tonnage under construction shown in another table—1,933,027 tons—shows an increase of about 82,000 tons as compared with the previous quarter, and is 1,513,531 tons below the highest pre-war record reached on June 30th, 1913, viz.:—3,446,558 tons. There are at the present time under construction in the world 22 vessels of between 10,000 and 20,000 tons each and 12 of 20,000 tons and upwards. Ten out of the 22, and four of the larger vessels, are being built in Great Britain and Ireland. The total figures include 57 steamers and motorships, each of over 1000 tons, with a total tonnage of 371,520 tons, under construction in the world for the carriage of oil in bulk. Of these tankers, 25 of 136,150 tons are under construction in Great Britain and Ireland, and eight of 55,000 tons in Holland.

The tonnage of vessels now being built in the world, which are to be fitted with internal-combustion engines, amounts to 905,675 tons, while the tonnage of steam vessels under construction is 1,005,224 tons. The motor tonnage is thus 90 per cent. of the steam tonnage. The tonnage of motorships being built at the end of December in Great Britain and Ireland—263,900 tons—amounted to 53¾ per cent. of the steam tonnage under construction. In Danzig, Denmark, Holland, Italy and Sweden the motor tonnage under construction greatly exceeds the steam tonnage; the combined totals for those countries being 397,401 tons of motorships and 102,096 tons of steamers. The world figures include 51 motorships each of between 6000 tons and 10,000 tons; 8 of between 10,000 tons and 15,000 tons; 6 of between 15,000 tons and 24,000 tons; and one of about 33,000 tons.

Still another table shows that the total horse-power of the engines being built or being installed on board vessels at the end of December, 1926, amounted to 1,696,055 horse-power, of which 720,735 horse-power are being built or were built in Great Britain and Ireland; 214,500 horse-power in Italy; 171,570 horse-power in Germany; 139,335 horse-power in the United States; 109,150 horse-power in France; 98,240 horse-power in Holland; and 242,525 horse-power in other countries. Excluding 95 engines of less than 500 horse-power each, the average horse-power of each set reaches 3535 horse-power; the average for reciprocating steam engines being 1663 horse-power; for oil engines, 3882 horse-power; and for steam turbines, 10,592 horse-power.

Water Supply in 1926.

No. II.*

Metropolitan Water Board.

Supply from the Queen Mary Reservoir.—Various works in connection with the supply from the Queen Mary Reservoir at Littleton were in progress during the year. The aqueduct or conduit which is to convey the water from the reservoir to the different works of the Board for treatment was finally completed quite early in the year. Eventually it will comprise two separate conduits, but at present only one has been laid, though the necessary outlet from the reservoir, to connect up to the second conduit, when it is laid, has, of course, been provided. This work was fully described in our issues of January 29th and February 5th, 1926. Briefly, the conduit consists of some 3840 yards of circular reinforced concrete tube, 6ft. in diameter, laid by the cut and cover method, followed by about 2880 yards of 48in. cast iron pipes laid in trench. Near the outlet from the reservoir connection is made with the aqueduct from the Staines reservoirs, and the conduit runs parallel with that aqueduct throughout its course, first on one side and then on the other. A most interesting portion of the work was the taking of the conduit under the aqueduct. Two views of the 6ft. conduit, one showing the reinforcement and the other the collapsible Blawform which was used for forming the conduit tube for a considerable portion of its length, are given herewith.

The construction of the additional pumping station at Kempton Park, particulars of which were given in our issue of January 15th last year, was approaching completion at the end of the year, the covering of the boiler house roof being in progress. The installation of the boilers and the erection of the two sets of vertical triple-expansion engines, actuating single-acting plunger pumps, will be commenced early in this year. The contract documents and drawings were prepared for the construction and installation of twenty-four open rapid gravity primary filters, each capable of filtering between one and two million gallons per twenty-four hours. These filters are similar to those at Walton, to which we referred in our first article. The building housing the control apparatus for the filters, and a central building with wash-water tank over, containing the air compressing apparatus and wash-water pumps, are arranged in cruciform shape in plan similar to those at Walton, a batch of six filters being situated on each side of the two legs. The effluent from the primary filters will be passed on to the existing slow sand filters, the filtering rate of which will be increased.

To deal with this increased output, it is proposed to lay an additional main for conducting filtered water from the secondary filters to the suction basins of the several pumps, and a contract will be let early this year for the laying of this main, together with supply mains from the primary to the secondary filters, and the branches from the Littleton to Hampton conduit to the primary filters, and fitting delivery connections from the new pumps to the recently completed main from Kempton to Cricklewood. The contract will also include the connections from the conduit to the existing low-lift pumps at Kempton, which will be brought into operation when the water level in the Queen Mary Reservoir is insufficient to afford the supply to the primary beds by gravity.

Works for the Improvement of Supply North of the Thames.—The laying of a main from Abbey-road, Hampstead, to Myddelton-square, Clerkenwell, for the augmentation of the supplies to the Board's northern district, was completed just before the end of the year. This main is a continuation of a 42in. main from Cricklewood—the laying of which was completed about eighteen months ago—and is 42in. in diameter from Abbey-road to Woburn-place, Holborn, where a 30in. branch is taken off, extending to Theobalds-road, where connections are made to existing mains. From Woburn-place to Clerkenwell the main is continued at 36in. in diameter. In the near future a contract will be let for laying a 36in. main, connecting with the above main at the junction of Albert-road and Park-street, Regent's Park, and proceeding through Camden Town and portions of Holloway to Brecknock-road, to augment the supply to existing mains from the Board's Maiden-lane reservoir.

During the past year, for the improvement of the supply to the Board's western district, a contract was completed for the laying of a 24in. main from Putney Heath to Gunter-grove, Chelsea, together with a connecting length of 24in. main from Fulham-road to Lillie-road, Fulham.

Works for the Improvement of Supply South of the Thames.—The work in connection with the construction of primary and secondary filters at Walton, together with the extension of the Board's existing pumping station and the installation of plant for pumping into supply was completed during the past year, as was also the laying of mains for supplying water from the Board's Honor Oak reservoir to the southern and Kent districts.

Works at Hampton.—The laying of a 48in. cast iron filtered water conduit along the Lower Sunbury-road, Hampton, for the improvement of the draw-off from existing filters, is being carried out.

Manchester.

Thirlmere.—The work of diverting the drainage of 2400 acres, forming the north-easterly part of the watershed, which was commenced in 1923, was completed towards the end of the year. It comprises about 2 miles of open watercourse with catch-pits and two short lengths of tunnel, and was carried out by administration at a cost of about £33,000.

Thirlmere Aqueduct.—The electrically-driven booster plant installed at Lostock, near Bolton, for pumping the water to be conveyed thereto by the fourth line of pipes, through the existing lines to the terminal reservoirs at Prestwich and Heaton Park, was completed in the early part of the year, and has since been tested with entirely satisfactory results.

Heaton Park Reservoir.—The construction of a service reservoir of 550 million gallons capacity at Heaton Park, about 4¼ miles north-east of the city, which was stopped owing to the war, in 1915, was resumed in 1922. During the past year 35,000 cubic yards of excavated material were taken for banking or spoil, 61,000 square yards of beaching and pitching completed, and 62,000 cube yards of clay puddle lining put in. The rainfall has been impounded since April, and at the end of the year the depth of water averaged 7ft. 6in. over 18 acres of the reservoir bottom. The work is being carried out by direct labour under the supervision of the waterworks engineer.

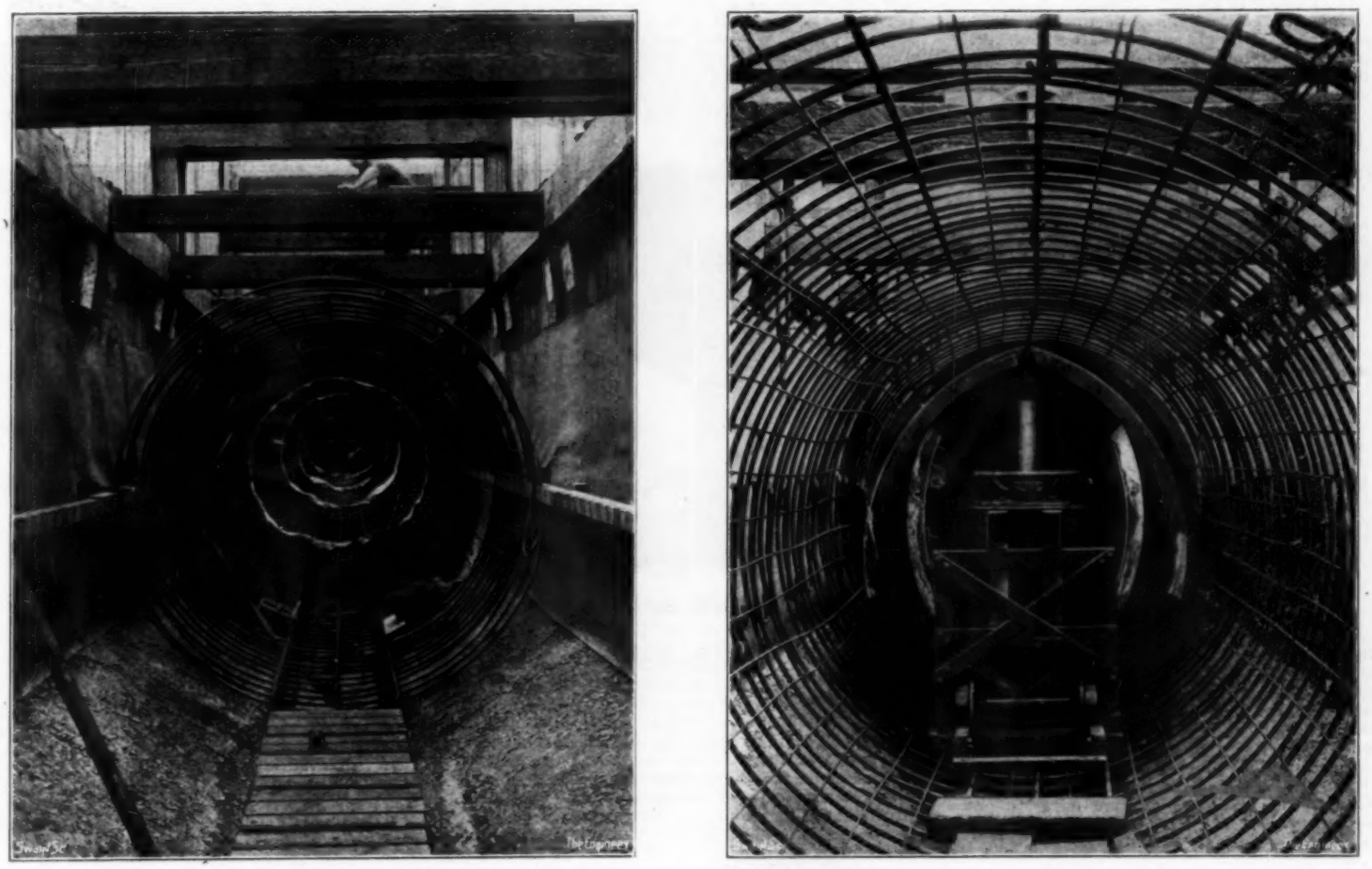
Haweswater Scheme.—The survey and the levelling of the intended line of aqueduct was completed, and the preparation of detail drawings is well advanced. The major portion of the land to be acquired in connection with the scheme was purchased and negotiations are in progress for the acquisition of the necessary easements.

Birmingham.

The water department of the city of Birmingham was engaged during the year on the construction of the Bartley reservoir, which forms a portion of the scheme by which additional supplies of water are to be taken to the city from the Elan Valley. As we are proposing to describe this reservoir in detail at an early date, we need not refer to it at great length. It may be explained, however, that the reservoir is to be formed by a dam built across a small stream. The impounded water will have a top water level of 605 O.D., and the lake formed will have a length of about two-thirds of a mile long, a maximum width of rather over a third of a mile, and a maximum depth at the dam of about 60ft. Its surface area will be about 125 acres, and its contents upwards of 500 million gallons. The contract for the work was let in February, 1925, and during last year a good deal of progress was made, including the construction of a core wall, which is built of reinforced concrete, since there was an entire absence in the near neighbourhood of clay suitable for making a puddle wall.

Cardiff.

The waterworks engineer, Mr. C. H. Priestley,



QUEEN MARY RESERVOIR CONDUIT, REINFORCEMENT AND COLLAPSIBLE "BLAWFORM" CENTERING

* No. I. appeared January 7th.

M. Inst. C.E., retired during the year, owing to age. He was succeeded by Mr. Neil J. Peters, M. Inst. C.E.

Llwynon Reservoir.—The construction of the Llwynon impounding reservoir, which has a capacity of 1260 million gallons, was so far completed that an opening ceremony by the Lord Mayor of Cardiff, Alderman W. B. Francis, J.P., was performed on June 23rd, 1926. Certain small completion works still remain to be carried out. The testing of the reservoir and the valves, including the Larner-Johnson discharge valves, was carried out during the autumn, water being impounded in the reservoir for that purpose, and so far as can be ascertained the whole of the work has proved to be satisfactory and water-tight.

Roughing Filters.—The roughing filters as erected by the Jewell Filter Company, and the pure water reservoir in connection therewith, were completed during the year, and put into service by the chairman of the Waterworks Committee, Alderman C. H. Bird, J.P., on June 23rd, 1926. Subsequent to that date tests were made of the filtering plant, which is giving satisfactory results.

Taff Fawr Pipe Line.—Progress was made with the laying of Taff Fawr conduit between the Cantref roughing filters and Llanishen reservoir, near Cardiff. The whole 14 miles of the 27in., about 5 miles of 30in., and 2¼ miles of the 24in. concrete-lined steel pipes are now laid, leaving approximately 7 miles still to be laid. Considerable delay occurred during the year owing to the coal difficulties, Messrs. Guest, Keen and Piggott's, the manufacturers of the pipes, being unable to supply any pipes after July. A large steel balancing tank, three bridges and three subways under railways, together with incidental works, were constructed during the year.

Wenallt Reservoir.—Owing to soft ground being discovered under the site of the Wenallt reservoir, it became necessary to close down the contract for construction, with which considerable progress had been made. Dr. H. Lapworth, of Westminster, and Dr. F. J. North, Keeper of Geology, of the National Museum of Wales, were called in for advice, and exploration of the floor site was carried out during the year. The result of these investigations were considered, and arrangements were made to proceed with the construction of the reservoir by administration during the coming year.

Wakefield.

The Ryburn scheme, for which powers were obtained in 1924, includes (*a*) the construction of two reservoirs in the urban districts of Rishworth and Soyland, to be formed by dams, respectively 134ft. and 100ft. high above the level of the stream; (*b*) a pipe line some 21 miles in length, consisting of 22in. and 20in. cast iron and steel pipes; (*c*) intake works, river, railway and canal crossings; (*d*) a tunnel in the urban district of Barkisland, some half-mile in length; and (*e*) a mechanical filtration plant at Kirkhamgate, near Wakefield, designed to filter 2·6 million gallons of water per day. During the past year contracts were let to the Stanton Ironworks Company, Ltd., for approximately 11,000 tons of 22in. and 20in. cast iron pipes, and to Stewarts and Lloyds, Ltd., for approximately 600 tons of 22in. and 20in. steel pipes, the latter pipes being lined with bitumen, ¼in. thick, centrifugally applied. The intake works, including a concrete dam some 30ft. in height, were completed, and about 2½ miles of cast iron pipes were laid, this work being carried out by administration. The contract for the Barkisland tunnel was let in July last to Messrs. H. Arnold and Sons, Leeds and Doncaster, and about 200 yards were driven. The contract for the pipe line from Barkisland to Wakefield, about 18½ miles in length, was also let to Messrs. Arnold and Sons, but owing to the coal stoppage no pipes were obtainable, and work has not as yet been commenced. The Corporation proposes to construct the lower of the two reservoirs, called the Ryburn reservoir, by direct administration. The access road to the site is being constructed and temporary buildings are being erected. It is expected that excavations for foundations will be begun this year. The filter house at Kirkhamgate is in course of construction, the contractor being Mr. H. Hainsworth, Wakefield. It is expected that the house will be roofed in and the erection of the mechanical filters by the Candy Filter Company will be begun next month.

Durham County Water Board.

The Muggleswick tunnel, completed during the year, is about 1¼ miles in length, and forms the last link of the aqueduct by means of which the Durham County Water Board is able to convey water from an intake on the Burnhope Stream—a tributary of the river Wear—near Wearhead to its Smiddy Shaw reservoir, situate on Muggleswick Moor, near Waskerley. The aqueduct consists of a line of 30in. pipes about 11¼ miles in length from the intake on the Burnhope Stream to the Stanhope tunnel, which is about 1¼ miles in length. This tunnel discharges into the Waskerley reservoir from which a connection to the Smiddy Shaw reservoir, is made by means of the Muggleswick tunnel. The tunnel is lined for practically its whole length with concrete segments of special design, devised by the resident superintendent, Mr. Richard Chamberlain. The work was carried out by administration under his supervision, at a cost of about £55,530. The scheme was originated by Mr. Henry Robinson, M. Inst. C.E., and in 1919 was adopted by the Weardale and Consett Water Company, the interests of which were subsequently transferred to the Durham County Water Board by the Act of 1922. The whole aqueduct has been constructed at a cost of about £322,500 under the direction and supervision of the Board's consulting engineers.

Nottingham.

Colwick Hill Reservoir.—On July 30th, 1924, the tender of Matthews and Mumby, Ltd., of Manchester, was accepted for the construction of the Colwick Hill concrete covered service reservoir, of about 3½ million gallons capacity, for the sum of £17,937. The reservoir is 280ft. long by 140ft. by 16ft. to the underside of the roof, the outer walls being 8in. thick at the top and 1ft. 5in. at the bottom. A division wall, 6in. thick at the top and 10in. thick at the bottom, has been built across the centre of the reservoir, to a height of 10ft. to facilitate cleaning operations or repairs. The floor is 6in. thick. The roof is 6½in. thick, and supported by 128 reinforced columns, 14in. in diameter. The concrete roof is to be covered over with 4in. of gravel for drainage purposes, topped by 12in. of soil, and the whole will be seeded down after the banks have been formed.

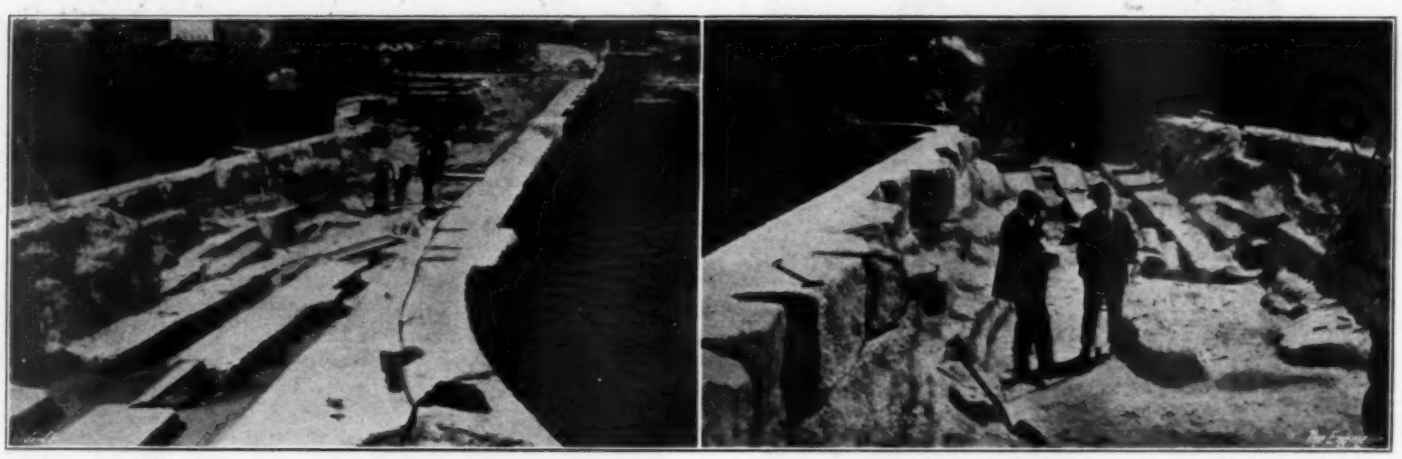
The roof is designed on the "flat slab system," and will be free to slide on the top of the outer walls, so as to permit contraction and expansion to take place without the risk of cracking the roof or walls. Plain steel circular bars, varying from ⅜in. to ⅞in., were used for the reinforcement, the concrete mixture being 4 of crushed gravel, 2 of sand and 1 of cement. About 13,000 cubic yards of earth were excavated, and about 2500 cubic yards of concrete and about 170 tons of steel reinforcement were required for constructional purposes. The water is controlled by valves situated in the basement of a recorder house, which is entered by means of a flight of steps built on the south side of the reservoir. Access to the interior of the reservoir is obtained by a flight of steps leading from the recorder house to the bottom of the reservoir. It is expected that the forming of the banks and other details will be completed in the early part of this year.

Eastwood Filtration Plant.—In addition to the foregoing the Water Department Committee decided to duplicate the mechanical filtration plant at East wood for dealing with the Nottingham portion of the water received from the Derwent Valley Water Board. The works, when completed, will consist of forty-two 8ft. diameter steel filter shells—Bell's design—sedimentation tanks, lagoons and the usual ancillary plant. The installation is to be capable of passing 6 million gallons of water per day. The objects of the plant are to remove the peaty sedimentary matter which is held in suspension in the water as received from the Derwent Valley Board and to increase the hardness.

Bore-holes at Burton Joyce.—An interesting scheme is shortly to be put in hand to pump water from three 18in. diameter bore-holes which have been sunk to a depth of about 500ft. into the Bunter Measures. The machinery will consist of bore-hole pumps and booster plant for pumping the water into the nearest service reservoirs. The necessary current to drive the motors will be obtained from the Corporation's power station at North Wilford, but as Burton Joyce is outside the Nottingham parliamentary electricity area, the current will be supplied through the Derbyshire and Nottinghamshire Electric Power Company, in the district of which Burton Joyce is situated.

Plymouth.

Good progress was made with the Burrator reservoir enlargement works during the year. At the Sheepstor embankment the excavation of the wing trenches was completed, and in a few weeks the whole of the concrete filling will be in position. At the eastern trench great trouble was experienced with water in large quantities getting in from the reservoir, which interfered with the work and necessitated the use of heavy pumping plant just at a time when the cost of coal and coke had greatly increased, owing to the coal dispute. The puddle wall in the centre of the embankment was completed and the embankment itself is nearing the finished height, while good progress was made with the laying of the granite pitching to protect the inner slope of the embankment. On the Burrator dam itself progress was made with the removal of the superstructure. Two of the arches carrying the roadway were taken down and a commencement was made with the removal of the face-work on the overflow. Two views showing this work in progress are given herewith. The eastern abutment of the bridge is now being raised to the new height. About 2 miles of new roads were constructed, and all the undergrowth cut and removed from land which will eventually be covered with water. The suspension bridge erected to carry traffic across the reservoir while the dam is being raised, which was brought into use the year before last, is doing excellent service, weights over 20 tons sometimes passing over.



REMOVING THE TOP COURSES OF MASONRY PRIOR TO RAISING THE BURRATOR DAM

Preston.

Good progress was made with the Alston reservoir, which is being formed by building an earth embankment with a clay core wall. Up to the end of the year 550,000 cubic yards of material had been removed from the floor of the reservoir and deposited on the banks. The earthwork was carried to within 10ft. of the top of the bank, and it is anticipated that, by the spring, half the pitching will be completed. The reservoir will have a top water area of 30 acres and will have a capacity of 250,000,000 gallons. When it is completed, Preston will own nine reservoirs with a total capacity of 1,000,000,000 gallons, which represents 170 days' full supply.

Londonderry.

The Banagher water scheme for bringing additional supplies to the city of Londonderry made good progress during the year. Four and a-quarter miles of roads for giving access to the reservoir site and intakes were completed, as were also five concrete bridges over streams. The trial trench for the concrete dam in the Altnaheglish Valley has been sunk to the rock on both sides of the valley, and is now

being put down below the bed of the stream. The contract for the Corrody tunnel was let in May to Mr. Robert Colhoun, and the work is being proceeded with. The quantities for the 21 miles of aqueduct are being taken out, and tenders for the work will probably be invited early this year. A contract was entered into in January with the Stanton Ironworks for the supply and delivery of cast iron and reinforced concrete pipes, and though the work was delayed by the coal strike, about 1600 tons of pipes are in the store yard. Contracts for steel pipes lined with bitumen were also placed with Stewarts and Lloyd, Ltd., and Cochrane and Co., Ltd., and part has been delivered.

Glasgow.

The works in connection with the raising of the level of Loch Katrine, which have been in progress for a number of years past are now rapidly approaching completion. The dam and by-wash were finished during the year, as were also the roads on the north shore of the Loch and the pitching of the loch banks, where such work was necessary for the protection of the roads. A few minor works have still to be undertaken, and for that reason the water in the Loch has not been allowed to rise to full level, but was, at the end of the year, about 2ft. 6in. below designed top water level.

Taf Fechan.

The progress of the Taf Fechan reservoir embankment—which will be 110ft. high, 1000ft. long and will create a reservoir with a capacity of over 3200 million gallons—and incidental works, which are being carried out by administration under the direction of the consulting engineers and Mr. Thos. F. Harvey, was delayed by the coal and other strikes. The work is, however, now rapidly approaching substantial completion, and impounding is about to begin. The whole of the headworks, including the Paterson filters, which will have a capacity of 7·5 million gallons a day, are expected to be entirely completed by midsummer, 1927, although it is possible that water may be supplied at a somewhat earlier date to those constituent authorities of the Board which may be urgently in need. The pipe line felt the effects of the coal strike most severely, as no pipes were delivered for several months, and there still remain about 1¾ miles out of a total of 20 miles, to be finished. It is anticipated, however, that the pipe line will be available as soon as the headworks are in a position to deliver water.

Mechanical Filtration Plants.

Bradford.—Several interesting mechanical filtration plants were put into operation during the year. First, we may mention that which Bradford constructed for dealing with the water from the Stubden reservoir, which forms some 10 per cent. of the total yield of the Corporation's water undertaking. Till the new plant was got to work, this water had been mingled with the remainder of the supply without treatment. The Stubden water is drained from an upland catchment area which is largely overlaid by peat. Hence it is stained with the peat, and more or less plumbo-solvent, depending upon the time of the year. It is, moreover, subject to pollution from farm operations which the Corporation could not control. The capacity of the reservoir is not large enough to allow sufficient time of storage for the elimination of any pathogenic germs that the water might contain. For these reasons, it was decided to filter the supply. The treatment plant consists of sixteen circular steel pressure filters, designed to deal with 2,000,000 gallons of water per day. The filters are of the closed pressure type, and are intended to work under a head varying from 30 lb. to 50 lb. per square inch. The reagents used are aluminoferric—sulphate of alumina—to coagulate impurities and remove the stain and a trace of lime or chalk to neutralise the acidity. The treatment is perfectly successful.

Exeter.—Exeter is another place with an upland supply which put a filtration plant to work during the year. The treatment plant, at its Pynes waterworks, consists of three sets of eight pressure filters, each set being capable of delivering 1,000,000 gallons of treated water per day to the high service.

Mid-Sussex Joint Water Board.—Another filtration plant to deal with an entirely different class of water is that at the Horsted Keynes pumping station of the Mid-Sussex Joint Water Board. We propose in the near future to describe in detail this interesting plant, which passed its official trials in September last, and it will be sufficient to say here that the raw water, though exceedingly pure both chemically and bacteriologically, is, nevertheless, heavily charged with iron and carbonic acid. By spraying, the gas is driven off and the iron is entirely oxidised and precipitated. Filters of the pressure type are used to eliminate the precipitate. They work without the aid of reagents, and produce a singularly clear filtrate. There are five filters, which, together, are capable of dealing with 34,000 gallons per hour.

Bombay.

During the year the finishing touches were put to the important undertaking to convey additional supplies of water from Lake Tansa to Bombay, known as the Tansa Completion Works. The project involved the construction and laying of upwards of 80 miles of 72in. riveted steel pipes, upwards of 27 miles of 57in. pipes and over 3 miles of 60in. pipes. The first pipes were made and laid in April, 1923. At the end of March, 1926, all the 72in. and 60in. pipes had been made and laid, and less than 10 per cent. of the 57in. pipes remained to be made. The scheme also included the construction of two steel bridges, known as Kasheli North and South Bridges respectively, which were both built in a surprisingly short period. Part of the work carried out during the year was the construction of a house to contain chlorinating machinery, and the erection of that machinery, which is designed to treat the whole of the supply coming from the lake, or, say, about 90 million gallons per day. The total cost sanctioned for the execution of the works amounted to about 3¾ million pounds sterling. Up to the end of March last about 3 million pounds sterling had been expended. The whole project, which is among the biggest engineering works that have been successfully accomplished in India, appears to have been excellently managed and carried out, and to reflect great credit on all who were connected with it, engineers and contractors alike.

Singapore, Water Supply from Johore.

During the past twelve months the laying of the pipe line on the island of Singapore was substantially finished, and of the 17 miles in the State of Johore, some 15 miles have now been laid. It is anticipated that the pipe line as a whole will be so far completed by March next as to enable an average flow of 4 million gallons a day to be abstracted from the Pulai by means of a temporary intake, and delivered after chlorination into one of the existing reservoirs on Singapore Island. During the year the excavation for the foundations of the masonry dam were completed, and masonry work is about to begin. A contract is to be let for the construction of the Fort Canning covered service reservoir in Singapore, which will hold 30 million gallons, with a depth of 25ft. The consulting engineers have received instructions to prepare the plans for the works of the second instalment, which will comprise (*a*) two earthen embankments to form the Pontian Ketchil reservoir, with an available storage capacity of over 2500 million gallons, and (*b*) a pumping station and pipe line, by means of which the water will be delivered to the filters to be constructed below the Pulai dam. The preliminary works—access road, anti-malarial measures, and camps—are already in hand, and the permanent work, to be carried out by direct administration, will commence about midsummer, 1927.

South Australia.

Some interesting information regarding the waterworks in South Australia were published during the year. It appears that the total capital cost of the waterworks in the State to date is nearly £10,500,000. The total length of mains laid is 5100 miles, and the area supplied with water for domestic and stock purposes is 20,000 square miles, which is claimed to be the largest area in the world supplied with water under one scheme. There are in the State twenty-four impounding reservoirs, with a combined storage capacity of 16,796,906,000 gallons; forty-five service reservoirs; seven pumping stations on the river Murray, one at the Blue Lake Mount Gambia, one at Burra, one at Hansborough, one at Palmer, one at Kensington, and one at Tod River. Altogether, 106 towns are supplied with water, including the metropolitan area of Adelaide. The estimated cost of the works in hand and projected at the present time exceeds 5 millions sterling. Some 5 miles of cast iron pipes are manufactured weekly at the Glanville ironworks, which are, as are the water and sewerage departments, under the control of the Hydraulic Engineer, Mr. Herbert E. Bellamy, M.I. Mech. E., and the pipe laying in the State exceeds 1 mile per day. There are 86,000 water meters, representing a capital expenditure of £500,000, in operation. Reinforced concrete structures are in general use, and several towers and tanks have been and are being built. The Woolpunda tower is 122ft. high and that at Loxton 111ft. high. The most important undertaking in hand at the present time is the Tod River water scheme, the expenditure on which to date has been 1½ millions sterling. The length of the trunk pipe line alone will be 240 miles, and it is expected that the length of the reticulation mains will exceed 1000 miles. The Hume Company is supplying 57 miles of 16in. steel pipes, cement lined, which are being manufactured at Thovenard, and the same company has supplied 15 miles of 8in. pipes of a similar class.

France.

The carrying out of water supply undertakings during the past year was seriously impeded by financial difficulties, and, so far as Paris was concerned, no special effort was made to accelerate the various works in view of the fact that, for the time being at any rate, the water supply is sufficient for the needs of the population. The completion of the aqueduct from the Voulzie, which cost much more than had been estimated, on account of unforeseen difficulties, increased the supply by 60,000 cubic metres a day. The Loing and Lunain have been made to give an additional 20,000 cubic metres, and the capacity of the filtering beds at Ivry has been increased for a further daily supply of 70,000 cubic metres. In less than five years the quantity of water available for Paris has been augmented from 550,000 to 700,000 cubic metres—from 121 to 154 million gallons—per day. During the same period the daily consumption rose from 400,000 to 532,000 cubic metres, the highest total for any single day being 660,000 cubic metres. Good progress was made with the works for bringing water from the sources of the Dragon, and it is expected that they will be completed this year, when another 20,000 cubic metres will be available. There appear to be no more sources from which to obtain supplies. The municipality is therefore obliged to rely for the moment upon the filtering beds at Ivry, which are to be still further extended, so that in 1928 they will be supplying another 100,000 cubic metres. Nevertheless, in view of the heavy increase of population, and the extension of Paris beyond its former girdle of fortifications, the problem of providing for future requirements is a very serious one. There is always, of course, a means of making up for any deficit in cases of emergency by sterilising river water by treating it with chlorine, and that has frequently been done, but the water so treated is said to taste, and this method of sterilisation is only employed exceptionally. Nothing has yet been done with the reservoirs which it is proposed to create in the Seine Valley—though the matter was further discussed during the year—and hopes are based chiefly upon the utilisation of the underground water in the Vals de Loire that are capable, it is affirmed, of providing practically unlimited supplies. It is stated even that a million cubic metres could be pumped daily without causing any appreciable fall in the underground level. As that would solve the problem once and for all, the municipal engineers are persevering in their efforts to break down the opposition of the local populations by proving to them that the Paris demands upon the subterranean water would not diminish supplies for local users or affect the level of the Loire. In view of the intention of the Municipal Council to devote more money to experimental pumping operations, the Chambers of Commerce of Orleans and of other towns interested expressed their determination to oppose strongly a scheme which they condemn utterly; but the Council hopes that, despite that opposition, it will be possible to effect a compromise. The case of the Paris municipal engineers is strengthened by what has been done at Besançon, where it was found necessary to double the supply of 10,000 cubic metres a day, and as that could not be done from the Arcier tributary, which has been utilised from the time of the Romans, it was found necessary to sink wells in the valley of the Doubs, where the strata of sand and gravel provide an excellent filtering bed. Three wells were sunk, each 13ft. in diameter, and each was provided with an independent pumping plant. This work was completed early in the year, and the results are declared to be highly satisfactory.

Other Works Abroad.

Of the numerous other works abroad, we can do no more than briefly refer to one or two. Auckland, New Zealand, has in hand the construction of an impounding dam in the Upper Huia Valley, which, it is estimated, will hold up 500,000,000 gallons of water. When it is finished the city will have available a daily supply of 19,000,000 gallons. The estimated cost is over £470,000. Barton, Ontario, is to construct a 250,000-gallon elevated reservoir, and to lay some 15 miles of pipes of various sizes at a cost of over 320,000 dollars. Durban's new waterworks at Shongweni are noteworthy in having what is thought to be the largest regulating valve ever made. It was manufactured by J. Blakeborough and Sons, Ltd., and is capable of passing 1100 cubic feet of water per second, or at the rate of over 590,000,000 gallons in the twenty-four hours. The works, which, it was hoped, would be completed last September, also included the boring of two tunnels over 1¼ miles in length and measuring 7ft. by 5ft. Work was begun on the laying of a pipe line to supply Kiukiang on the Yangtze River, near the hill station of Kuling, with potable water. There is on foot an extensive scheme to provide some twenty residential and industrial towns within 30 miles of Chicago, having rapidly rising populations at present totalling half a million, with water from Lake Michigan. It is proposed to take the water from the lake at a point some 3 to 5 miles from the shore where the water is quite pure, and would not require treatment. Pumping against a head of 300ft. will be necessary. The initial cost of the scheme is put at £2,000,000. The port of Jeddah, on the Red Sea, installed a second sextuple-effect fresh-water distilling plant, which is designed to produce 150 tons—33,600 gallons—of potable water every twenty-four hours. Valparaiso is considering a joint hydro-electric and water supply scheme, which would provide it with from 180,000 to 200,000 cubic metres—say, from 39,500,000 to 44,000,000 gallons—of water per day. The length of the aqueduct would have to be 125 miles. The head available for power purposes is more than 5000ft. An extensive waterworks plant is being constructed at Shanghai by the Chapei Electricity and Waterworks Company. The water is to be drawn from the Whangpoo River, and passed to two coagulation basins, thence to twelve rapid sand filters and two chlorinators. The

filtered water will be pumped by electrically-driven pumps to five service reservoirs, with a total capacity of 975,000 gallons and to a water tower capable of holding 170,000 gallons. The capacity of the plant is to be, at first, 10,000,000 gallons per day, and the estimated cost is £200,000. The order for some 20,000 tons of pipes for use in connection with the Rio Claro water project of the State of Sao Paulo, Brazil, was awarded during the year to Braithwaite and Co. (Engineers), Ltd., of Westminster. This project necessitates conveying the water a distance of 80 kiloms. In addition to the pipes, there will be 44 kiloms. of concrete aqueduct and 4 kiloms. of tunnel, which, where necessary, is to be lined on the Braithwaite system with Armco iron plates. Although practically all the new construction work which it was intended to carry out during the year in connection with Kong Hong water supply was delayed, a new pumping engine, making the fifth unit, was erected and put to work in July at the Tai Tam Tuk station. It is capable of pumping 3,300,000 gallons per day on a lift of 387ft. A scheme was drawn up for supplying Sydney and Canberra with water from the Snowy River. It would involve a pipe line 220 miles long, and an expenditure of £33,000,000. A fall of 1570ft. would be available for the production of 40,000 horse-power. The dam across the river would be 62ft. high, and would provide a daily supply of 150,000,000 gallons. Extensions of domestic water supply in Mombasa and Dar es Salaam were under consideration during the year. Toronto, which very heavily chlorinates its water, has this year been installing a de-chlorinating equipment for the whole volume of water treated, at a cost of 30,000 dollars. The reagent employed is sulphur dioxide.

Irrigation.

In different parts of the world a very large amount of irrigation is in progress. In a review of this nature it would be hopeless to endeavour to give a list of even the most important projects, and we shall attempt no more than to mention a few that were completed during the year or are in progress or contemplation.

Though the Sennar Dam on the Blue Nile, which is intended to irrigate some 300,000 acres in the Gezira Plain was completed in 1925, it was not actually opened until January 21st, 1926, when the ceremony was performed by Lord Lloyd. Two highly important schemes in the Bombay Deccan were completed. One, the Nira Canals Extension, necessitated the building of the Lloyd Dam at Batghar. This huge structure is 190ft. high and 5333ft. long at the crest. It impounds 24,000 million cubic feet of water, and forms a lake with an area of 15,000 square miles. It will irrigate 900,000 acres. The second scheme has to do with the Pravara right and left bank canals, and for it the Bhandardara dam was constructed. It is 270ft. high and 1600ft. long. It impounds 13,000 million cubic feet, and commands an area of 183,000 acres. The scheme for the conservation of the waters of the Lachlan River in New South Wales includes the erection of a dam at Wyangala, near Cowra, at a cost of £1,352,000; an increase of the storage at Lake Cudgellico, at a cost of £75,000; and the construction of a series of low weirs between Goolagong and Booligal, at a cost of £137,500. The Egyptian Government gave its approval to the construction of a dam on the White Nile at Gebel Aulia, near Kartoum, with a barrage at Nag Hamadi in Upper Egypt. The work, it is estimated, will take three years to carry out, and will cost about £6,000,000, not taking account of subsidiary developments. The proposed Upper Bhavani irrigation scheme in the Coimbatore district of the province of Madras is to involve an expenditure of approximately £35,000,000, the acreage irrigated amounting to at least 260,000. It is proposed to construct a masonry dam across the river Cauvery at Metur, to impound 90,000 million cubic feet of water for irrigation purposes. Work is proceeding in the Niger Valley on an important scheme of irrigation, which is to permit of the creation of extensive cotton fields. The Suleimanke, which is the first of the four weirs to be built in connection with the Sutlej Valley irrigation project, was completed. The Argentine Government approved the expenditure of 6,500,000 pesos on irrigation works. Among the various water storage schemes now in course of construction in Victoria, there are the Hume dam, which will hold up 1,100,000 acre-feet of water; the Sugar Loaf Dam, which is to impound 306,000 acre-feet; and the extension of the Glenmaggie scheme from a storage of 50,000 acre-feet to 150,000 acre-feet. The Chilean Government has in hand irrigation projects in the provinces of Atacama and Coquimbo, which are to cost 25,000,000 pesos. In the first-named district the Lautoro River is to be canalised, while in the second, district reservoirs are to be constructed and the waters of the Laguna and Gogoti lakes are to be impounded. Some 50,000 acres have been irrigated by the construction of two dams—the Grassridge and the Lake Arthur—in the Great Fish River Valley in South Africa. The latter dam, which was completed during the year, holds up over 50,000 acre-feet of water. This is only one of many similar projects in progress in South Africa at the present time. A dam, 53 m. in height, is to be constructed across the Enza Torrent, which forms the boundary between the provinces of Parma and Reggio Emilia, in Italy. It will impound some 60 million cubic metres of water, which will be used partly to produce electric power and partly for irrigation by means of a diversion weir downstream at Guardasone. Some 11,300 hectares are to be irrigated. The Haitean Congress authorised the expenditure of 10 million dollars on irrigation canals and other public works. The contract was signed for the construction of a dam across the river Lerma, near Contepec, in the State of Michoacan, in Mexico. The dam will hold up 500,000,000 cubic metres of water, which, in addition to producing electric power, will be used for irrigating some 50,000 hectares of land. The cost is to be about 9,000,000 dollars. Work on the great Sukkur barrage undertaking proceeded during the year.

Fuel Research.

THE Fuel Research Board of the Department of Scientific and Industrial Research has only just issued its report for 1925. We have not the space to deal with it at much length, but reprint the chairman's introduction, written in July last, which summarises the work of the year 1925 and gives some indication of future activities.

IN our last report we outlined generally the work carried out since the appointment of the Board in 1917, and summarised the results obtained. In the present report we shall deal only with the progress during the year 1925. The report of the Director of Fuel Research presented herewith, and the appendices, give details of the work carried out and we propose here to refer only, and briefly, to the more outstanding items.

The work of the Physical and Chemical Survey of the National Coal Resources, which is one of the most important of the research activities, has progressed steadily in the two areas where committees have been established prior to 1925, and three more committees have been established during the year, namely, for the Scottish, the North Staffordshire, and the Nottinghamshire and Derbyshire areas. These committees have been but recently formed and arrangements are in hand for providing the staff and laboratory accommodation necessary before field work can begin.

The importance of methods of sampling and analysis of coal is being increasingly realised, and may have an important bearing on our export trade, as foreign buyers are becoming more critical as to the quality of coal supplied and are more and more inclined to purchase to a specification. Foreign coal producers are alive to this tendency, and are taking full advantage of it. The methods of analysis recommended in the interim report, issued in 1923, have, in essentials, stood the test of time and have obtained very general acceptance. A final report, embodying such minor amendments as have been found desirable, is in course of preparation. The question of sampling, especially of large commercial consignments, is one of great difficulty, but considerable progress has been made by the special sub-committee dealing with the question.

We consider that the work of the survey, both in ascertaining the properties of the various coal seams as they occur, and as they are or might be prepared for the market, and in working out methods for the sampling of commercial consignments of coal, is of prime importance to the coal industry of the country, as well as to all large users of coal.

In view of the importance of this work we have recommended that a memorandum giving the history, objects, and progress of the survey, which was written for another purpose, should be brought up to date and appended to this report in spite of the fact that it was dealt with at considerable length in the director's report for the period ended December 31st, 1924.

Investigations have been continued into the use of vertical gas retorts, and a report has been published during the year* on "The Enrichment of Coal Gas by the Injection of Oil into the Retorts During Carbonisation." The effect of the tube used for the oil injection has been further studied with and without water cooling, and the effect of increasing the throughput has also been studied. It has been found possible to increase the throughput up to double the normal, at any rate when using certain coals. The effect of this is interesting as tending in some respects to yield products akin to those generally associated with lower carbonisation temperatures. Further work is required before any very definite statement can be made; this is proceeding.

The setting of experimental horizontal gas retorts was completed in December, but was not fully heated up by the end of the year.

The work on low temperature carbonisation of coal has continued at the Fuel Research Station, and further details will be found in the director's report. The large scale experiments have been confined to the attempt to develop continuously working vertical metal retorts with the object of obtaining good lump coke suitable for domestic use, and at the same time the maximum yield of oil-producing tar. This type of retort was selected as it is one which, if successful, should be suitable for use with a wide range of coals, and is not being developed elsewhere. We must again point out that there are many processes and types of retorts, and that it is highly improbable that any one type will finally be developed to the exclusion of other types. Each has its own peculiarities and the question of the one to be adopted in any case depends on the particular circumstances of that case.

In our last report we stated that "a simple continuous vertical retort has now been elaborated, which is working smoothly and producing tar and cokes, while the labour required to run the plant is reduced to an amount comparable with ordinary gas works practice. Though this plant appears very hopeful, a concluded opinion cannot be formed on its industrial value until it has been working steadily for a long period, as only after considerable experience under steady working conditions will it be possible to estimate at all closely the cost of working and the depreciation of the plant."

The retorts referred to are those designated as the "B" retorts in the director's report. Difficulties developed with long continued working, due partly to the design of the extractor gear and partly to gradual distortion of the retorts. Two new settings were erected during the year, those first completed—known as the "D" retorts—worked satisfactorily for some weeks, but became distorted, the distortion being sufficient to prevent smooth working. The second setting—known as "E"—was completed later, and care has been taken not to raise the temperature sufficiently to cause distortion. It is intended to raise the temperature very gradually with a view to obtaining the maximum information before serious distortion takes place. The information gained will be utilised in the design of further retorts of special materials, which it is hoped will determine finally what possibilities exist in this type of retort.

As has already been pointed out, it is necessary, if reliable results are to be obtained, to work with full size retorts. Such retorts take some months to erect, and the results of working under any particular conditions of temperature, throughput, &c., can only be ascertained after working for an extended period with the conditions constant. The problem can only be considered solved when a full size unit plant has been in steady operation for a period sufficient to prove that the depreciation and maintenance of the retort is sufficiently low to make commercial working possible. A few weeks or months may be sufficient to prove that a plant is not commercial, but some years are necessary to give a proof that it is really satisfactory.

Various types of low temperature carbonisation plant are being developed by private firms and individuals, but progress is necessarily slow, and is in some cases hampered by lack of funds. Close touch is being kept with these activities and such technical assistance as is possible is given to those concerned.

We should like to draw attention to the tests of low-temperature carbonisation plants which the Government has authorised the department to carry out. The tests carried out during the year are dealt with in the director's report, and the conditions under which they are carried out are given in an appendix. We consider these tests as important in giving reliable data on certain aspects of the plants tested, and in assisting all concerned in the technical development of the process. From the nature of the case no opinion can be expressed on the commercial applications or prospects of any plant, as these depend on factors other than those dealt with in the tests.

The increase in the staff has made it possible to carry out further systematic work on a smaller scale, to determine the effect, on the gas, tar and coke produced, of variations in the temperature of carbonisation. At the same time laboratory investigations into the nature of the gas and tar are continuing, while a general research is being carried out into the reactivity of coke. Other laboratory investigations bearing on various aspects of the problem of carbonisation of coal are in progress.

Investigations into the nature and properties of low-temperature tars can be divided into two groups, first those connected with the treatment of the tar in bulk with a view to its utilisation as fuel oil, with or without separation into various grades of oil, such as motor spirit, Diesel oil, &c.; and second, a laboratory investigation into the constituents of the tar, and its possible use as a source of fine chemicals, paints and other products for uses other than as fuel. Arrangements have been made for this second group of investigations to be carried out more particularly at the new Chemical Research Laboratory of the department recently erected at Teddington, while the first group is being studied at the Fuel Research Station. Close touch is naturally being maintained between the two groups of workers, as their respective investigations, though distinct, are still closely connected.

The bacteriological work at the Royal Naval Cordite Factory, Holton Heath, has continued with the object of obtaining power alcohol from cellulosic materials. A by-product of this investigation has been the preparation from straw and other vegetable substances of a binder for use in briquette making. A binder of this type has been developed to some extent by the Pulp Binders' Development Company of South Africa, and the process is connected on the bacteriological side with the manufacture of artificial stable manure, which is being developed elsewhere for agricultural purposes. Preliminary laboratory experiments are promising, and it seems possible that the method may produce a cheap and effective binder. It is too early to venture on any prophecy, but should it be successful it may have a very important bearing on the low temperature carbonisation problem and the manufacture of "artificial" fuel from coal-dust.

Two reports have been published on domestic heating, and arrangements are being made for further work in collaboration with the Building Research Board of the Department, at the new research station near Watford.

One of the most important events of the year was the appointment of the Royal Commission on the Coal Industry, to which the Director of Fuel Research was appointed an assessor. This has naturally occupied a large portion of his time and a considerable proportion of that of his staff. The director communicated to us certain memoranda on the utilisation of coal prepared in this connection, which we considered of such general interest that we have recommended they be published, though not originally prepared by him with that intention. The portions of more general interest are accordingly published in an appendix.

* 1925.

EDUCATIONAL INTELLIGENCE.

A SPECIAL course on Acetylene Welding will be held at the School of Engineering and Navigation, High-street, Poplar, E. 14, on Friday evenings, from 7 to 9 p.m., commencing Friday, January 21st, 1927. The course will consist of twelve lessons on the theory and practice of acetylene welding and will embrace the following syllabus:—Explanation of process; preparation of materials; effects of impurities; blow-pipes; fluxes; gas pressures; effects of excess carbon and oxygen; general defects; metal cutting; welding of cast iron; welding of thick and thin sheets; testing and after-treatment of welds. Particulars can be obtained from G. H. Gater, Education Officer, The County Hall, Westminster Bridge, S.E. 1.

Sanitary Engineering in 1926.

General.

THE only thing of special note is the extension which has taken, and is taking place, not only in this country, but abroad as well—especially in the United States and Canada—in the employment of the activated sludge methods of treatment of various types. Although, however, there is no outstanding development in connection with sanitary engineering to chronicle, there were, nevertheless, some interesting events. Among them was the laying, for the first time on a commercial scale, of sewer pipes by thrust boring. Lines of cast iron pipes were successfully taken in two places under the Grand Junction Canal, to the westwards of London. The lengths of pipes, which were 60ft. 6in. and 86ft. long respectively, were laid truly to the desired gradients.

The Birmingham, Tame and Rea District Drainage Board, which has for some time now been experimenting with a small power plant driven by gas obtained from sewage sludge, decided to install a larger plant at a cost of just over £12,500, by means of which it is hoped to generate electricity for power purposes in sufficient quantity to effect a saving of more than £1100 per annum in the cost of current used for operating machinery at the Saltley works.

A proposal was put forward by the Farnham and Alton Rural District Council to form outfall works adjacent to Frensham Pound in connection with a scheme of drainage for Hindhead and Grayshott. The proposal met with violent opposition as it is feared that the suggested works would seriously injure what is undoubtedly one of the most famous beauty spots in Surrey.

There were two interesting incidents—quite dissimilar in character—in connection with materials used for filter beds. One was that, during the coal stoppage, many thousands of tons of coal which was used as filter bed material at the Esholt disposal works, was removed and sold for fuel. The other was that it was reported from the United States that it is proposed to use corn or maize cobs after they are depleted of their berries as filter bed material. It seems quite possible that they would, owing to their rough surfaces, do very well for the purpose, if they did not rot It is suggested that if and when they were no longer of service, they would provide a good fuel for furnaces.

Another piece of news from the other side of the Atlantic was that at Marion, Ohio, it had been found that by covering up sludge beds and providing them with glazed roofs, three times as great a quantity of sludge could be dried in a given time as with open beds. The report says nothing regarding the relative costs of the two methods.

A curious means for forming concrete culverts, said to be of Japanese origin, was demonstrated in Sydney. A trench for the pipe was excavated and at the bottom was laid an inflated rubber tube. Concrete was tamped round the tube, and, when it was set, the tube was deflated and withdrawn.

The Royal Sanitary Institute celebrated its jubilee by organising a Congress in London in the early part of July. It was attended by over a thousand delegates.

Works in Progress or in Contemplation.

We give below some details of works which were either completed or in progress during the year. In addition to them there was a great deal of work in hand, or which received consideration or was in course of preparation during that period. There was trouble, of course, owing to the coal stoppage, but for all that a not inconsiderable amount of progress was made, and in several cases treatment works were completed, and put to work. At the following places works, each involving an expenditure of £80,000 or over, were either in progress or in contemplation :—Barking, Bexhill, Birmingham, Bolton, Brighton, Chesterfield, Coseley, Huddersfield, Ipswich, the Wandle Valley, Redruth and Rothwell, and Southend. Important works were also in hand at Ashford, Bedford, Bournemouth, Camborne, Cosham, Droitwich, Easington, Epsom, Gelligaer, Heysham, Knutsford, Maidenhead, Oswestry, Richmond, Rochester and Chatham, Sedgley, Sutton-in-Ashfield, Uxbridge, Whitley and Monkseaton, Winchester, and Wirral. Works of lesser magnitude were also in progress in very many other places.

London Main Drainage.

Most of the important works comprised in the scheme designed for the relief of storm flooding in the Metropolis, the total cost of which was estimated on a pre-war basis at about £2,500,000, made good progress during the year, and in many cases were completed. During the year no new works were begun, but the following have been finished :—(*a*) The storm water pumping station, Hammersmith ; (*b*) the south-western storm relief sewer, which runs from Brixton to Nine Elms, a length of about 2¾ miles, the greater part being 11ft. 4in. in diameter ; (*c*) the Lewisham branch sewer. This sewer, which is designed for the relief of floodings in Lewisham and district, runs from Bell Green, Lower Sydenham, to a junction with the southern high-level sewer No. 2 near Court Hill-road, Lewisham. A branch sewer will be constructed from Catford Station. The total length of these sewers is approximately 3 miles. The sewers have been constructed principally in tunnel in brick work with internal diameters varying from 5ft. to 9ft.; and (*d*) the Beverley Brook relief culvert, which is a concrete culvert, 8ft. in diameter, designed to carry the flood waters of the Beverley Brook from Priest's Bridge, Upper Richmond-road, direct to the river Thames.

Work proceeded on the following works, which are nearing completion :—(*e*) The Eltham sewer. This sewer, which is designed for the relief of floodings in Eltham, Kidbrooke, Greenwich and Woolwich, runs from Eltham-road, near Eltham Green, to the southern high-level sewer No. 2 at Charlton. It is about 2½ miles in length, 8ft. internal diameter, and is being constructed partly in brick and partly in iron, principally in tunnel ; and (*f*) the north-western storm relief sewer. This sewer is intended to relieve floodings which have occurred from time to time in parts of Willesden, Kilburn and Hampstead. It consists of about 5½ miles of sewer, including branches, varying from 4ft. 6in. to 9ft. 6in. in diameter. Its outlet where storm water will discharge into the river adjoins Hammersmith Bridge. All the sewer is constructed in tunnel, and the lower portion is shield driven, lined with cast iron with considerable portions carried out in compressed air.

Manchester.

Main Drainage.—In connection with the main drainage of Manchester, "work No. 5," which was commenced in 1924, and which was in progress during the whole year, is now nearing completion. It comprises a sewer, 4 miles in length, varying in size from 12ft. diameter to 4ft. 9in. diameter. A large portion of the work is in running sand, and was constructed in cast iron lined with brick and concrete, the operations being carried out under compressed air. The construction of the Gorton relief sewer, which varies in size from 3ft. 9in. diameter to 12in. pipes, was almost completed. Work was commenced in March on the Withington and Didsbury intercepting sewer, which is 1¼ mile long, varies in size from 4ft. 6in. to 3ft. diameter, and is from 20ft. to 30ft. deep.

Outfall Works.—Work in connection with the extension scheme, involving an expenditure of £464,000, which was formally approved by the Ministry of Health in September, 1925, was commenced. A special loan of £114,000 was granted, and work is still in progress in respect of the construction of offices, new detritus tanks and screening chambers. Considerable progress was made with the main to carry sludge from the Davyhulme works to an area of land in Flexton and Carrington, amounting to about 200 acres, which was already in the possession of the Corporation. Completion of the work was held up by the non-delivery of the pipes, owing to the coal strike. Drawings and estimates of costs for the construction of activated sludge plants to deal with a dry-weather flow of 18 million gallons per day and proportionate storm water—16 million gallons dry-weather flow—by the diffused air method and 1,000,000 gallons dry-weather flow by the Simplex and Sheffield systems, will shortly be submitted to the Ministry of Health for its approval, and it is anticipated that the work will be put in hand early this year.

Bradford.

On May 5th, 1926, a formal opening ceremony of the new Esholt works was performed by Mrs. Johnson, wife of Alderman Richard Johnson, chairman of the Sewage Committee and of the West Riding of Yorkshire Rivers Board. The tunnel outfall sewer, 2¾ miles long and 10ft. diameter, detritus tanks, screening plant, storm water bay, storm water tanks, and the inverted syphons across the Aire Valley, were all completed during the year. Of forty precipitation tanks, thirty-three were finished, and it is expected that the remaining seven will be ready for service some time about the middle of 1927. The scheme provides for the erection of a plant for the manufacture of sulphuric acid used for precipitating the sewage and the erection of the first unit of that plant was commenced. Twenty-one acres of bacterial filters out of the 60 acres proposed in the scheme had been completed before the miners' strike, but in order to keep the essential services of the city of Bradford in operation—that is, the gas and electricity works—and to give a supply for household purposes, 12 acres were, as explained above, denuded of the coal which was used as a filtering medium. It will therefore take some little time to bring the full 21 acres into operation again.

Leeds.

In connection with the Thorpe Stapleton sewage scheme, Leeds carried out a good deal of work during the year. Actual figures as to the progress made during the whole twelve months are not available, but during the year ending September 30th last 1½ miles of high-level intercepting sewers had been completed at a cost of £61,500, making the total length to date 7½ miles, the cost being £341,071. The construction of the tanks and of the channels for the low-level precipitation tanks, bacteria beds and storm water tanks at the high-level works are proceeding satisfactorily. The construction of the humus tanks at the high-level works, which are estimated to cost £85,000, was begun towards the end of the year. The capital expenditure during the year, including that on sewers, was £180,700, and the total expenditure at the Thorpe Stapleton works since they were begun in 1908 amounts to £1,876,000. An extension to the Rodley works, which is to cost some £24,000, is due for completion in March next. During the year Mr. George A. Hart, M. Inst. C.E., who had been in charge of the works from the start, vacated the position of sewerage engineer in order to take up an appointment in New Zealand, and Mr. E. H. Howat on has been appointed in his stead.

Leicester.

Various storm water and sewage disposal works were carried out during the year by Leicester, which has, by the way, lost during that period the services of a very able servant by the resignation of Mr. E. George Mawbey, M. Inst. C.E., for many years city engineer and surveyor. His place has been filled by the appointment of Mr. A. T. Gooseman. The extensions of the Abbey pumping station were completed, and the pumping machinery is being erected, two of the three pumps having been got into position before the end of the year. When fully in operation, these pumps will be capable of delivering at the rate of 36½ million gallons of sewage per day against a head varying from 129ft. to 164ft. The rising mains were laid up to the sewage farm—on which the new works are more than half completed—while the electrification of the Beaumont Leys effluent pumping station is well in hand and the construction of the storm water tanks at the Abbey pumping station is about one-quarter done. The last contract to complete the extensive scheme being carried out, namely, that for the construction of detritus tanks, sewers, &c., at the Abbey pumping station, is about to be let, and it is hoped to begin that work early this year. When that contract is let, over £600,000 worth of work will be in hand.

Portobello (Edinburgh).

Although powers to carry out the work were granted in the first instance some twenty years ago, it was only in July last that a large tidal tank sewer at Portobello was put into service. As a matter of fact, constructional work on it was not begun until about two years ago. The length of the new sewer, which cost between £50,000 and £60,000, is 2062 yards, and in it the sewage will bank up during times of high tide to be automatically discharged into the Forth when the tide falls. A good deal of difficulty was experienced when carrying out the work, owing partly to the tides in the Firth.

West Kent Main Sewerage Board.

The new disposal works at Long Reach, Dartford, of the West Kent Main Sewerage Board, were formally put into service in July. The sewage, after screening and being passed through detritus tanks, flows to the precipitation tanks—of which there are twenty-four, each measuring 75ft. by 65ft., and having an average depth of 8ft. 3in.—the combined capacity of which is just over 6,500,000 gallons, with tides in the river of ordinary dimensions. These tanks are arranged in six sets of four each, and the treatment consists of allowing the sewage to flow continuously through sets of four tanks, which are furnished with weirs across their full widths.

France.

The past year was one of preparation rather than of the actual carrying out of sanitary engineering schemes, and even in the devastated areas, where so much has still to be done, though on a comparatively small scale, there was an entire absence of activity. Work was arrested by lack of funds, but it is understood that renewed efforts will be made this year to complete the work of reconstruction. In Paris some important schemes are still under consideration, especially for the disposal of sewage in some of the eastern suburbs, where the conditions are very bad, and a commission which visited those areas declared that no time should be lost in dealing with this matter. At present much of the sewage finds its way into the Seine above Paris. The scheme provides for the laying of a collector or main from the suburbs to the works at St. Ouen, where the sewage is first treated by sedimentation, the lighter sewage being then sent to the farms. The St. Ouen works are to be considerably enlarged, and a new sewage farm is to be laid out at La Frette, not far from the Achères farm, which long ago reached its full capacity of absorption. This undertaking will be very costly, and its realisation is retarded by the difficulty of settling upon the participation of the various bodies interested. As the Government has decided to hasten forward all public works with a view of providing for the threatened unemployment, it is probable that something will be done with this, as well as with other schemes, during the present year. It has also been decided to put down new incineration plants for the disposal of house refuse. Further evidence of the determination of the Paris Municipal Council to improve the sanitary system generally is afforded by the new by-law requiring all landlords to provide suitable domestic sanitary arrangements, for while

that has long been compulsory, there is still much to be desired. While, therefore, sanitary engineering made little headway during the past year, it gives promise of showing more activity in the coming twelvemonth.

Other Works Abroad.

Throughout the world there are many sanitary engineering works in progress or which were completed during the year, and we mention a few of them below. In March last the South Australian Government approved a comprehensive scheme of sewerage works for the Adelaide area, which was designed by Mr. H. E. Bellamy, the Government Hydraulic Engineer, and which is estimated to cost £1,400,000. Construction work on the undertaking was pushed forward during the rest of the year. At the present time all the sewage is dealt with on a farm by a system of broad irrigation, but it is proposed to supersede the farm by activated sludge treatment works. The Calcutta Corporation adopted a scheme for the more efficient drainage of the city, at a cost of nearly two crores of rupees—say, £1,500,000. The scheme includes the construction of a new pumping station off the Ballygunge, which will be the corner stone of the work, as it will help to drain a large portion of the city, now practically undrained and often waterlogged during the rains. Benoni, an important town in the Transvaal, is carrying out a sewerage scheme, estimated to cost of £100,000. An extensive drainage scheme, estimated to cost 2,723,000 rupees, or, say, £204,000, was sanctioned by the Municipality of Karachi. A big scheme of sewerage and drainage was entered upon by the important Bolivian mining town of Oruro, which has long suffered from inefficient sanitation. The cost of the undertaking and of some waterworks that are also to be constructed, is estimated to be £450,000. It is understood that contracts for a good deal of the work are to be placed in this country. Durban adopted a scheme of sewerage and storm water drainage that is to cost £375,000. In quite another part of the world, Haifa, on the coast of Palestine, asked an English engineer to go out and report upon a scheme of sewerage and sewage disposal. In Palestine, too, drainage operations were in progress in the Brook of Kishon area. The Fuara stream is being dammed, so that its waters may be diverted into other channels, with the result that a large area, now a malaria-breeding swamp, will be made dry. In April, New York put into service a sewage treatment plant which has been installed with the object of preventing the grosser solids from being discharged into the Hudson River and New York Harbour. The plant is arranged under a street and comprises a series of three revolving inclined screens, made of perforated manganese bronze plates operating in tanks. These screens catch and convey the solids above the surface of the sewage, where they are swept off by brushes into hoppers leading to a storage tank. From there they are forced pneumatically into special trucks to be conveyed to barges and taken far out to sea for dumping. The partially clarified sewage is pumped into a sewer which discharges into the Hudson.

An Improved Back-pressure Turbine

DURING recent years the demand for low-pressure steam for process work has been considerably extended, and as the temperature of the steam required is low, it has become common practice to generate steam at relatively high pressures and to utilise the energy in the steam in a turbine before applying it to the process work. Two types of turbine, namely, the steam extraction or pass-out turbine, and the pure back-pressure machine may be employed, but from the point of view of efficiency the latter offers considerable advantage, provided a reasonable balance can be obtained between the electrical energy and the steam required for process work, or that the surplus electrical energy generated can be sold for lighting or other purposes outside the factory. On the Continent, where this point has long been very fully appreciated, many back-pressure turbines are being installed, and the matter is also claiming considerable attention in this country, especially in districts where there are large textile factories.

When it is possible to install a back-pressure turbine, the user reaps material benefits, for apart from the elimination of losses attributable to windage in the low-pressure portions of the pass-out machine, running under back-pressure conditions only, the fundamental advantages of many stages and consequent low steam velocities may be secured. The illustrations which are given on page 46 are views taken in the maker's shop of a back-pressure turbine designed and built by the English Electric Company, Ltd., for the Dhrangadhra State Chemical Works. The machine, which exhausts against a back pressure of 30 lb. per square inch, is designed to give an economical output of 675 kilowatts, at a speed of 3000 revolutions per minute, with a maximum overload of 1125 kilowatts. The boiler pressure under these conditions is 240 lb. per square inch, and the steam is superheated 140 deg. Fah. A noteworthy feature of the turbine is that it is fitted with nozzles—see Fig. 1—machined from the solid, with the result that an accurate and well designed steam path is secured. The efficiency of a steam nozzle is, of course, very dependent upon its accurate size, shape and finish, and the employment of nozzles machined from the solid is said to have resulted in a marked improvement in the results obtained, as compared with the older and more general type of cast nozzle. From the preliminary test run in the shops on this particular machine, the results obtained are said to have proved very satisfactory, and to have shown beyond doubt that the machined nozzles are advantageous.

The nozzle blade itself is cut from a rectangular bar, and after passing through various processes of manufacture, it assumes its final shape, as shown in Fig. 1. The nozzles are inserted into mild steel centres after which they are drilled for the reception of rivets, and the whole is welded up. Two retaining rings are also welded in the inlet and outlet sides of the plate, thus giving a diaphragm equivalent to one that is machined from the solid. As the diaphragms are supported by means of keys, they are held central in their casing, but at the same time they are free to expand in a radial direction, thus eliminating any possibility of stresses being imposed upon the housing, which consists of a steel casting, the high-pressure end of which forms the steam belt for the introduction of steam, and

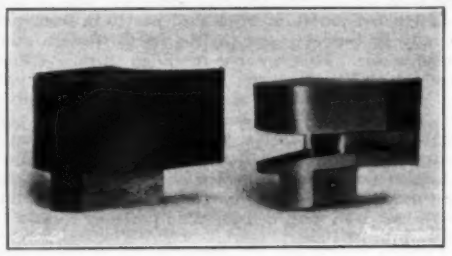


FIG. 1—MACHINED NOZZLE

extends throughout the machine, thus eliminating any question of leakage at the joints.

The turbine rotor—which is shown in Fig. 2—is turned from a solid forging of Siemens-Martin steel, and the wheels are thus formed complete with the shaft—a form of construction which, in addition to reducing the disc stresses to a minimum, compatible with their speed of rotation, enables factors of safety to be used that are not possible when the wheels are separate from the shaft. The gland diameters between the stages and at the steam and exhaust ends are also reduced so as to give a minimum amount of leakage, and thereby to improve the efficiency. To insure that the forging from which the rotor is turned is sound, test pieces are taken from between each of the wheels, and a hole is also bored through the centre of the shaft so that the core or heart of the forging can be examined by means of a boroscope, in order to remove any doubt as to the strength of the rotor. In fact, this practice is claimed to enable a more detailed examination of the rotor to be made than is possible with the more usual form of construction.

The glands at the high and low-pressure ends consist of carbon rings made in three segments and held together

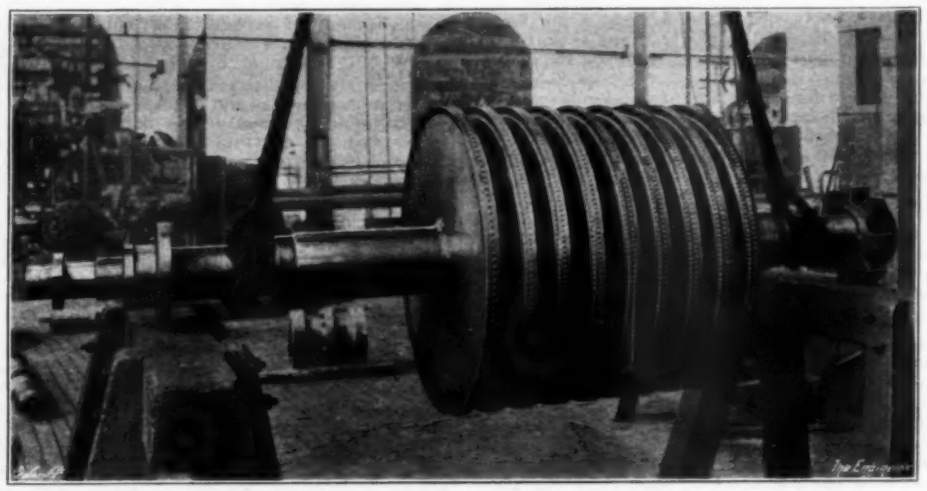


FIG. 2—ROTOR FOR BACK-PRESSURE TURBINE

by means of garter springs, each of which is contained in mild steel lantern rings. For the purpose of baffling the steam between each stage of the turbine, copper strips are let into the diaphragms, and as the ends of these strips are reduced to a knife edge, no trouble is liable to arise in the unlikely event of the rotor coming into contact with the strips. Provision for expansion on the machine is made by permitting the steam end pedestal to slide upon a key placed coaxial with the machine, whilst the clearance between the stationary and rotating parts is obtained by means of a Michell thrust block, which is combined with the bearing in this pedestal, so that the turbine is free to move in an axial direction, whilst at the same time no reduction is made in the axial clearances of any of the working parts.

The governor gear—see the lower view on page 46—is of the usual relay type, and consists of a servo-motor directly coupled to the main throttle valve, which is operated in turn through a float lever by the governor by means of a distribution valve. The overload is obtained by by-passing the third and fifth stages, the valves for supplying steam to which being hand operated. In addition to closing the main stop valve, the ring type emergency governor also closes the main throttle valve, so as to insure safety. A turbine-driven auxiliary oil pump comes into operation during the starting up period and also when the machine is shutting down, and it also comes into operation in the event of the main oil pump failing, whilst in the unlikely event of both these pumps failing, the turbine is automatically brought to a standstill.

The alternator coupled to this turbine was also built by the English Electric Company.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

THE January quarterly meeting of the Midland iron trade was held in Birmingham to-day—Thursday. There was an exceptionally large gathering of representatives from all parts of the kingdom anxious to gauge the future position in this market and to resume negotiations with firms which for many months past have not been in a position, owing to the cessation of activities at the works due to the coal strike, to do business. The general tone of the market was one of optimistic anticipation, though it was realised that the first six months of this year are going to be difficult for industrialists. The disorganisation caused by the strike is not yet a thing of the past. In the basic trades there are heavy arrears of orders to work off. Many of the metallurgical branches are assured of regular employment in supplying current demand, and at the same time replacing stocks which have been exhausted during the stress of the past year. But a large proportion of the orders which have to be cleared off in the heavy industries were taken at prices based on lower production costs than those which now obtain. Though in some cases present orders are being given out at current higher rates to agree with those already on manufacturers' books, this is not always acceptable to all consumers, and losses on old contracts are bound to be incurred. Iron and steel masters are heartened, however, by the prospect of an early release of new business of considerable magnitude. Midland firms have participated in large contracts for rolling stock and electrical equipment, as well as for structural work. Bridges for the London docks are to be supplied from the Black Country. Contracts and sub-contracts have been placed for the first section of Birmingham's electricity scheme. Developments of considerable extent are foreshadowed by other public authorities in this part of the country; and the carrying into effect of the plans for unifying, co-ordinating and extending the country's electricity resources should provide a powerful impetus to trade. The better prospects in the shipbuilding yards will also have an effect on industry in this area. Black Country chain and anchor makers, nut and bolt manufacturers, and producers of ships' tackle received but little assistance from this quarter last year, and they join local iron and steel masters in welcoming the increase in activity in the shipbuilding industry, and hope that at last this trade has taken a turn for the better. At this time, when business looks so bright, it is regrettable that the effect on production costs of the late dislocations should have driven prices of raw materials to their present high level. In many branches of trade it is evident that demand is being held back on the assumption that prices are on an artificial basis, and that buyers have only to wait to obtain substantial concessions. However, consumers must realise, with fuel at its present price, that production costs have not yet reached anything like pre-strike level. True, values of iron and steel, with increasing supplies becoming available, tend to depreciate, and there is little doubt but that manufacturers are anxious to restore the normal basis of values with as little delay as possible. At to-day's quarterly meeting producers of iron and steel sought to insure adequate supplies of fuel at reasonable rates, and consumers of their products, though equally anxious to cover their material requirements, hesitated to place forward contracts at present ruling prices. In some instances agreed terms resulted in the booking of large orders.

Fuel Prices Retard Progress.

Industrial fuel prices are the crucial point in to-day's market situation. On 'Change to-day and throughout the week iron and steel masters and manufacturers generally have been urging the necessity for further reductions in prices of coal and coke maintaining that the high price of this essential commodity is retarding progress towards any real trade revival. Midland blast-furnacemen maintain that they must have more security in the matter of coke before they can re-commission furnaces. Available supplies are committed, the requirements of the numerous furnaces which have been restarted in the north making a very heavy drain upon restricted output. The stringency in the Cleveland district has been marked

by an increase of 2s. 6d. in the price of coke. There has been a sympathetic stiffening of quotations in Birmingham, but it scarcely amounted to a definite advance. The price which has been mentioned, 20s. at ovens for new contracts to agree with the old, would not be an insurmountable barrier probably, though it could only mean that pig iron would cost, for a time at all events, more than is consistent with a genuine hardening of trade. Even if the price question could be adjusted, however, supplies are so restricted as to give no security to furnace owners. Neither South Yorkshire nor South Wales coke is coming forward with any freedom, defects which had developed through the cooling down of ovens having been revealed when they were started up anew. In these circumstances the re-commissioning of Staffordshire, Derbyshire, Northamptonshire and Lincolnshire furnaces is being approached very cautiously.

Manufacturers and Cheaper Coal.

Midland manufacturers complain bitterly of the continued high cost of works coal. They argue that with increasing output and the longer working day, prices should now be lower than before the stoppage. The unnecessary retardation of the decline in coal prices is, they claim, a serious matter preventing them from successfully competing in the trade arena. Cheap coal they maintain must be one of the main factors in the recovery of our lost trade. They assert that if the high price of coal continues manufacturers will be forced to consider other means of obtaining the power they require. In this connection much attention is being given to recent developments in the use of electricity and fuel oil for power-producing purposes.

Pig Iron.

Pig iron production is being impeded by the uncertain and unsatisfactory position in the fuel trade. Furnace owners are unprepared to take the risk of blowing in furnaces without a guarantee of adequate supplies of coke. Moreover, fuel at present prices, they state, must of necessity mean, at any rate, a continuance of the present high level, if not an advance, of pig iron prices. This they realise consumers would be unprepared to pay. Indeed on 'Change in Birmingham to-day users of pig iron declined to do business at current rates, being convinced that there will be a fall in values in the immediate future. There was not much inquiry for any Midland brand. Furnaces which are already producing and which are in a position to deliver what they sell according to schedule have disposed of most of their output over February. For Derbyshire No. 3 £4 5s. at furnaces is paid for February and March. Consumers are not anxious, however, about buying for the third month. For Northamptonshire No. 3 £4 to £4 2s. 6d. is asked. Middlesbrough iron is offered at £4 2s. 6d., which, when rail charges are added, makes the price £4 17s. 6d. in the Midlands. Continental iron has been delivered in good quantities on contracts placed during the strike, and some of the accumulation at continental ports is being got rid of. Continental prices generally are easier, and intensified competition from this quarter is expected now that the British works are again producing. Basic pig is now actually being produced at the blast-furnaces at Bilston. It is understood that arrangements have been made for re-kindling several additional Northamptonshire furnaces before the month is out. Other Midland plants will be re-commissioned as quickly as possible.

Awaiting Steel Supplies.

Though an increasing amount of steel is coming on to the market it is insufficient to meet the demand, and engineers, particularly in the structural branch, are "held up" awaiting supplies. The steel department is not likely to feel the effect of the increased output of pig iron until the end of the month. Quotations are difficult to obtain, and deliveries cannot be promised in some cases in less than four months. Delivery of steel plates has been promised four to six months ahead. Competition for the available supplies is keen, and quotations are irregular and difficult to determine. In many cases they are influenced by individual circumstances. A change in the Association basis was in some quarters looked for. When the market opened angles and joists were quoted £7 17s. 6d. to £8 and even £8 2s. 6d.; flats, £8 7s 6d.; and rounds, £8 17s. 6d. For ship, bridge and tank plates prices ranged from £8 17s. 6d. to £9 2s. 6d., according to specifications. For small bars as much as £9 was asked, though a few houses were prepared to accept half-a-crown to five shillings below that figure. High-carbon billets appeared to be an improving market. Very few soft billets, of British manufacture, are yet available. Steelmasters on 'Change to-day expressed the opinion that heavy business will be forthcoming in the near future, and every effort will be made to provide Midland engineers with all they may require, and to keep deliveries to date. Given abundant fuel there should be no difficulty, and a year of remunerative activity should follow last year's idleness. Steelmasters are hopeful that such will be the case. There is so much lee-way to be made up that a continuous period of prosperity is necessary to accomplish it.

Staffordshire Bar Iron.

The Staffordshire finished iron trade shows increased activity, and supplies of all brands are increasing. Ironmasters on 'Change to-day spoke very hopefully of the future. Many of them have very well filled order books, and inquiries for supplies are numerous. Engineers anticipate that their demands for best bars will be far in excess of last year's, and they are anxious to come to terms. Up to the time of writing no change in the basis price of £14 10s. for marked bars had been decided upon, nor was it considered a likely move. Consumers who cannot get ample supplies are hoping the puddling furnaces will soon be able to do more to relieve the dearth of finished iron. Lancashire houses are competing for the Crown bar business by offering supplies at £12 10s. Staffordshire makers contend they cannot, with profit, sell at less than 7s. 6d. to 10s. above this figure. Most makers to-day quoted the full £13. Common grade bars suitable for the nut and bolt and kindred industries are now on offer, the figure quoted being £11 to £11 5s. Nut and bolt makers have recently benefited by orders placed by the shipyards and the chain and anchor trade is also expecting a good deal of business as activity is resumed in the shipbuilding industry. Under these circumstances the demand for merchant bar iron is expected to increase considerably as the quarter advances. Belgian competition is keen, and nut and bolt and hurdle bars are offered at £6 10s. delivered. The malleable ironfounders of the Black Country are busy, having a steady trade with the automobile industry, which has received something of a filip since the year set in.

Galvanised Sheets.

In the galvanised sheet trade the downward trend of prices seems to have been checked for the time being, and 24-gauge corrugated sheets stand at £16 5s. There is a fair inquiry, and makers have booked good orders for overseas. Mills have enough work to keep them busy at least until the end of the month.

Scrap.

The scrap market shows a rising tendency. Demand for this material has improved since the settlement of the strike, and some of the heavy stocks, especially of steel scrap, accumulated in the idle period are now being disposed of. A lot of scrap has been ordered from the Continent, and deliveries are expected to bring down prices in this country.

Railway Rates.

Birmingham and the Black Country, by reason of their geographical position and nature of their industries, will perhaps be hit more severely than any other district in the Kingdom by the proposed increase in railway rates. Iron and steelmasters, engineers and manufacturers hereabouts are naturally dismayed at the prospects. At the present time, when industry is struggling against grave difficulties, any increase in transport charges must be a heavy handicap. In the case of such industries as the iron and steel, indeed where the cost of transporting three or four tons of raw material must be added to that of carrying away every ton of finished product, the increase cannot fail to be multiplied to an altogether alarming extent. Of course, as Mr. Bilbrough, the railway expert of the Birmingham Chamber of Commerce, has pointed out, having regard to the large percentage of traffic in this area in classes seven to ten, carried at exceptional rates, the effects of the increase in the schedule may be considered merely nominal, because the exceptional rates now in operation will be carried on in the future, subject to the increase agreed upon by the tribunal. He expressed the hope that so far as the exceptional rates are concerned it will be found possible to carry traffic at existing charges. One can readily understand industrialists in this district regretting the action of the railway companies, since for some considerable time they have been agitating, through the Chamber of Commerce, for a reduction in transport charges. Everyone interested in trade revival will regret the increase, but it is difficult to see how anyone can get behind a unanimous judgment of the Tribunal. It should be borne in mind, however, that price increases may reach a stage when they defeat themselves. The railways have only to raise their charges to a certain level to drive a great part of their traffic permanently on to the roads, or so seriously to handicap those industries which must of necessity make use of the railways that the volume of traffic will seriously diminish. Already for numerous and increasing classes of traffic the railways no longer have a monopoly. Road transport is developing to a very marked extent, and industry, if railway rates rule too high, will turn to the roads before it allows itself to be handicapped too severely.

Warwickshire Coal Agreement.

The new agreement between the Warwickshire coal owners and miners which will come into operation on July appears to have given pretty general satisfaction. The present arrangement—basis rates plus 65 per cent., as compared with 46·67 per cent, in April, 1926—will be continued until July, after which month the wages payable will be based on an ascertainment of profits earned in the industry during March, April, and May. Under the new agreement the division of the surplus will be 85 per cent. to wages and 15 per cent. to profits. The wages will not be lower than 43 per cent. above basis rates. This 43 per cent. compares with 42½ on Cannock Chase, and is stated to be the highest minimum percentage in the country.

West Midland Miners and District Settlement.

It is remarkable how little interest is evinced by miners in the West Midland area in the terms of the district settlement. The apathy is so great that there is every prospect that the settlement of the coal dispute in this area will develop into one of pit agreements. The miners' agent has held a series of meetings in the area for the purpose of obtaining the instructions of the men with regard to a district settlement, but these gatherings have been very sparsely attended, and those who have been present have declined to accept the responsibility of giving the agent the necessary power to negotiate on their behalf. As a result, no further steps have been taken to secure a district settlement, and the negotiations which were commenced are likely to fall through.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Orders for Textile Machinists.

A SERIES of interesting contracts for textile machinery of various types has been announced during the last few days, and if the hopes of further Russian orders materialise Lancashire makers should be assured of a steady run. The most important is the contract, valued at £400,000, which John Hetherington and Sons, Ltd., Manchester, are said to have received for the equipment of an artificial silk mill, the Branston factory, formerly belonging to Crosse and Blackwell, which has been acquired by the Rock Investment Company, a concern which secured control of Messrs. Hetherington's business about two years ago. Orders for weaving, spinning and preparatory machinery for Brazil have also been placed with Messrs. Hetherington, and also with Platt Brothers, Ltd., Oldham, whilst Brooks and Doxey, Ltd., Manchester, has secured an order for heavy doubling machinery for the Mayfield Mill, Hamer, near Rochdale.

More from Russia?

Russia has again been prominent as a possible further buyer on a large scale of Lancashire textile machinery. In the second half of 1925 and in the early months of last year, a number of engineering firms in this area—notably Platt Brothers, Hetherington and Sons, Tweedales and Smalley, Mather and Platt, and Brooks and Doxey—received orders for textile plant from Russia to the aggregate value of £1,600,000. Most of it has already been shipped, and the remainder is expected to be sent off within the next three months. The Russian Textile Syndicate is negotiating now with Lancashire firms for further substantial quantities, the question of credit terms being the crucial factor. In respect of the contracts approaching completion, it is said that the business has been very satisfactory, and that their financial obligations have been promptly met by the Russians.

Cable from Holland.

Salford City Council has placed another contract for cable with a Dutch firm—Nederlandsche Kabelfabriek, of Delft—after a lengthy discussion, for the third or fourth time within the last twelve months, of the ethics of the situation. The Dutch tender was £2740 for 9000 yards of low-tension and 450 yards of extra high-tension cable, a figure which was 36 per cent. below the most favourable quotation submitted by British manufacturers. The high figures quoted by British makers were alleged to be due to the existence of a ring which prevented free competition coming into play. To combat this, the suggestion was thrown out by one member of the City Council that there should be a combination of cable-buying municipal authorities. An amendment, which urged that the recommendation of the Electricity Committee should be referred back for further consideration, was defeated by 28 votes to 7.

A New Power Station.

In connection with the proposal of the Lancashire Electric Power Company to erect a new power station at Kearsley, the Engineering Advisory Committee has now recommended the South-East Lancashire Electricity Advisory Board to approve of the work being proceeded with. Previously, the Manchester, Salford, and Oldham Corporations had been approached by the Engineering Advisory Committee to ascertain whether they would be willing to extend their existing stations in order to meet the demands of the Lancashire Electric Power Company, but in their replies none of the three Corporations quoted for bulk supplies as alternatives to the company's scheme. It is of interest to note that Bury Town Council has now approved recommendations for an extension of the Chamber Hall power station, the cost of the first part of the scheme being estimated at £99,000.

A Profit-sharing Scheme.

The first distribution under a profit-sharing scheme instituted at the end of last May by James Mills (Engineers), Ltd., engineers and boilermakers, of Heywood, has just been made, the employees receiving a sum equivalent to nearly three weeks' wages, including a payment made at the time of the Heywood holidays. Briefly, the scheme provides for the payment of 10 per cent. on the capital of the company—7½ per cent. for dividend and 2½ per cent. for the reserve fund—and the next £50,000 profits to be divided to pay seven working days' wages for holidays, the balance to be shared *pro rata* to wages received among the employees, and any other profits to be divided equally between the firm and the employees. A monthly house magazine which the firm now publishes states in its latest issue that the order books are in a healthy condition, and that the prospects for the current year are bright.

A Business Arrangement.

A report that Sir W. G. Armstrong, Whitworth and Co., Ltd., had made arrangements to relinquish control of the business of Charles Walmsley and Co., Ltd., engineers, of Elton, Bury, which they have held for several years, has been officially confirmed this week.

Non-ferrous Metals.

Tin continues to be the most noteworthy feature of the non-ferrous metal markets. There has been some buying by continental interests, but home consumers are not yet operating to any great extent. At one time during the past week a rather important advance in quotations was made, but this was more than lost within the next day or two, and at the time of writing quotations for prompt metal are about £2 10s. per ton less than they were a week ago, although the difference in the case of forward is rather less than this. The statistical position disclosed by the December estimates has probably had a bearish influence, for the visible supply is estimated at about 15,000 tons, or an increase of nearly 1100 tons. Trade buying of copper has been on a moderate scale, but as offers for sale were pretty considerable, prices have lost further ground on balance, to the extent of about 5s., values now ruling being the lowest for over ten years. Heavy offers of lead from the Continent and a cut in American quotations adversely influenced the market, prices easing off. Demand for lead, however, remains quiet. Offers of spelter during the past week have exceeded the demand, and values in this section have also had a setback.

Iron.

A week ago Derbyshire iron makers were asking 92s. 6d. at the furnaces for No. 3 foundry pig for January delivery and 85s. for February, but the general quotation now for forward business is at the latter figure, which is equivalent to 92s. 6d. per ton delivered in this district. In some cases makers are trying to secure a little more than this for prompt delivery. As a matter of fact, bookings are on a limited scale, and although blast-furnaces have a lot to do to catch up with deliveries, it is evident that the position is less strong than it was. So far, however, this has not been reflected to any appreciable extent in the case of Middlesbrough or Scottish makes. Cleveland iron is quoted here this week, delivered Manchester, at 97s. 6d. to 98s. per ton, and Scottish at 112s. 6d., with West Coast hematite on offer at 95s. to 96s. per ton, also delivered. Bar iron manufacturers are still booking only small orders, but quotations are unchanged from what they were a week ago, although here again, presumably, consumers are looking for lower levels before indulging in free buying. Crown quality bars are on offer at £12 10s. per ton, and seconds at £11 5s., including delivery.

Steel.

The steel market keeps quite firm, and the tone here is rather more cheerful than in the case of pig iron. Although there is no sign of the boom which has been so much talked of in the Press, there is undoubtedly a brighter outlook, a fair volume of inquiry being reported from several quarters. Joists and sections are maintained at £7 17s. 6d. to £8 per ton delivered, tank plates at £8 17s. 6d., boiler plates at £8 10s., and basic steel bars at about £9. There is only a quiet demand for small re-rolled bars, which, however, are unaltered at £9 5s. per ton. For acid wire billets £12 10s. per ton is being asked for special quality, and £11 for ordinary. Galvanised sheets remain slow and easy at about £16 per ton f.o.b., parcels still remaining unsold in export markets, particularly India, in spite of lower prices being quoted than are ruling here. The demand for continental steel remains at a low ebb, and further reductions are now announced, joists and sections being offered at £6 10s., light plates at £7 5s., Siemens plates at £7 12s. 6d., sheet bars at £6, and billets at £5 17s. 6d. per ton, for cash against documents, and including delivery to works in the Manchester district.

Scrap.

The position of non-ferrous scrap is much as it was a week ago, the demand being slow. Scrap zinc is on offer at £25 10s., lead at £28, clean light copper at £55, brass rod turnings at £39, and selected gunmetal scrap at £52, for sorted qualities delivered to users' works.

BARROW IN-FURNESS.

Hematite.

There are now twelve furnaces in blast in this district and in a month or two this number may be increased to seventeen. There is an insistent demand for deliveries from all directions, and for the next six months makers will be busy attending to them. In the meantime deliveries are being made, and there are plenty of signs that as present orders are cleared customers will be placing further contracts. The feeling is general that the whole position is changed, and that the future demand for iron will be regular and on a bigger scale than has been experienced for some years. The market is firm and likely to remain so. The business done recently in special qualities of iron is good, and good business is promised in ferro-manganese. It is not possible to say what the business will be with America or the Continent, but more orders are likely to come from the former than the latter. The iron ore mines are at work, but are not at full strength yet, although it will be only a matter of a month or so until the full number of furnaces will be in blast. It is expected that there will be a bigger business in hematite ore with outside customers. Foreign ore will soon be arriving.

Steel.

The Barrow rail mills are again running, and the hoop mill is fully employed. The small section mills will soon be running again. At Workington the steel works will shortly resume activity, when rails, tires and sleepers will be turned out. There is not much life in the steel trade at present, but makers have lost time to make up, and it is expected that there will be enough orders to keep the steel departments going for about six months. In the meantime fresh orders are expected.

SHEFFIELD.

(From our own Correspondent.)

Heavy Trades Expanding.

ALTHOUGH there has been no further re-commissioning of open-hearth steel furnaces, the steel trade continues to make satisfactory headway. Sufficient steel is now being produced to meet the immediate urgent requirements, and makers seem disposed to await events before entering upon further developments. The cost of pig iron is a good deal higher than before the coal stoppage, but with the price of furnace coke falling, and more blast-furnaces operating, prices should shortly be more reasonable from the steel makers' point of view. As a matter of fact, there is no general buying and anything in the nature of forward business is quite out of the question. There is still plenty of leeway to be made up, and no time will be lost in doing it, as soon as the market conditions become properly adjusted. But even in spite of the present restricting conditions, there is considerable activity in both the iron and the steel trades. One of the blast-furnaces at the Thorncliffe Ironworks of Newton, Chambers and Co., has been got ready for work, and the Staveley Coal and Iron Company has brought three more blast-furnaces into operation. A start has been made with the bar mill of the United Strip and Bar Mills, which have a good deal of work in hand, and the Templeborough cogging mill is also operating. Other plants which have had a long spell of idleness are also gradually resuming as conditions permit.

More Coke Ovens Operating.

Another batch of seventy coke ovens has been started at the Devonshire Works of the Staveley Coal and Iron Company, and the number now operating, 135, is the same as before the stoppage. Blast-furnace coke that is marketed is still several shillings a ton higher than the old rates, and there is still a scarcity of the special coke used in the Sheffield crucible steel trade. The high price of this coke—the latest quotation is 50s. a ton for immediate business and 45s. for a twelvemonth contract—is not at all to the liking of the steel makers. Owing to the facts that the prices of their finished products are fixed, and that it would be most inadvisable to raise them, they have apparently to continue to do, for some little time at least, what they have had to do throughout the greater part of the coal stoppage—bear the whole of the extra fuel costs themselves.

Polish Crucible Steel.

A Sheffield man, Mr. B. Pashley, who was formerly with Samuel Osborn and Co., has returned to England from Poland on a holiday, and he gives an interesting account of how he and a number of other Sheffield men, who had gained wide experience in steel works in the city, are now supervising the first crucible steel-making plant in Poland. This plant was commenced about eighteen months ago by the firm of Hosayb, of Warsaw and Pruszkow, which was formerly a customer of Sheffield for its crucible steel. About 4 tons of steel are produced each week, all of it being utilised in the country. About twenty Poles are working under the Englishmen, and, although they have much to learn in the matter of steel melting, they are described as being very willing and energetic workers. Mr. Pashley, commenting on the attitude of the employers towards their men, states: "They are as good masters as ever I had in my life. I have found that they do as much for their workmen as they can. But at the moment, things are not too prosperous, either for employers or employees, though things are getting better, and I believe there is a big future for Poland."

Sheffield's Lighter Trades.

A satisfactory amount of work is passing in the lighter steel trades, but there are no particularly outstanding features. The steady progress that the engineering trades are making, and the necessity for certain replenishments after so long a stoppage, has resulted in good business for tools from the home market. The export section holds plenty of opportunity for expansion, but in view of all the circumstances the position cannot be said to be unsatisfactory. The amount of inquiries to hand gives every ground for encouragement. The plate and cutlery trades are experiencing the usual period of comparative inactivity which follows the Christmas holidays. This quietness, however, is not general, and a few firms report that they are quite busy on special orders. The next half-yearly meeting of the Council of the National Association of Goldsmiths will be held in Sheffield on January 20th.

Technical Work Endowment.

In conjunction with the Master Cutler of Sheffield and representatives of the local industries, the Armourers and Braziers Company, of London, has endowed a scheme for the benefit of technical workers of Sheffield. It is pointed out in the details issued that the object of the scheme is to encourage members of trade societies to take a keener interest in their work and to discover improved methods. The endowment is to consist of £150 to be given annually by the Company during its pleasure. The scheme is to be administered and managed by an Executive Committee, consisting of the following members:—*Ex-officio* the Master Cutler of Sheffield; elective, one member each of the Armourers and Braziers Company, the Cutlers' Company of Sheffield, the University of Sheffield, and the Sheffield Trades Technical Society.

Staveley Coal and Iron Company.

Some important developments that are pending in connection with the Staveley Coal and Iron Company were mentioned by Mr. D. N. Turner, the managing director, at a dinner at Chesterfield, given by the company to its colliery officials. Last year one of the biggest gas engines in the world was erected at Devonshire Works, and waste gases were employed to drive it. This year a second engine of a similar size will be installed alongside the first, and a third is on order. When all three engines are running they will generate 15,000 kilowatts of electricity. During the strike, and when all the pits were shut down, the company generated 7,000,000 units of electricity, and was able to continue to supply various villages and works. Another development is a plant to clean the waste gases as they leave the blast-furnaces, and a further scheme is the building of a bridge over Hall-lane, Staveley, which will cost from £15,000 to £20,000. The following interesting statistics concerning the company's activities were given by Mr. Turner:—At Devonshire Works 45,000 tons of material are handled every week; the pipe works make 1000 miles of pipes a year; there are 70 miles of high-tension lines on the company's premises and about 15 miles of underground cable; the company employs about 15,000 men, and turns out about 2½ million tons of coal a year, yet there are only 420 ponies and horses in use, a tribute to the progress that has been made with mechanical haulage. Many companies with a much smaller output use five times as many ponies.

Colliery Amalgamation.

Another amalgamation has been made by agreement in West Yorkshire, and took effect from January 1st. The collieries concerned are Locke and Co. (Newland), Ltd., the proprietors of St. John's Colliery, Normanton, and the Victoria Coal and Coke Company, Ltd., the proprietor of Parkhill Colliery, near Wakefield. Following the amalgamation there will be combined working of these two collieries and coalfields, joint marketing of products, and interchange of plant, machinery, rolling stock and colliery accessories. In addition to these collieries a further sinking at Normanton, known as St. John's No. 2, is in an advanced state, and it is expected that at a very early date there will be an additional output exceeding 1500 tons of coal per working day.

NORTH OF ENGLAND.

(From our own Correspondent.)

Railway Rates.

THE decision of the railway companies to increase freight rates has caused some consternation in trade circles in the North of England, and protests are being made on all hands. Certainly it is very unfortunate just when there appears to be a possibility of the iron and steel industries receiving some benefit from cheaper fuel, which would play an important part in the recovery of its export trade, that the railway companies should increase their rates. The increases proposed are certainly a serious menace to the rapid recovery which must take place if the iron and steel industries are to attain their proper position.

New Coal Pit at Seaham.

Although there is a long way to go yet before workable coal is won, the rate of progress, especially considering the stoppage during the strike, of sinking the new pit at Seaham, to be known as the Londonderry Colliery, has been wonderfully rapid. The first seam will be reached at a depth of 1506ft., and the deepest seam is the Busty, at a depth of 2100ft. Sinking is proceeding at the rate of between eight and nine feet per day, and, if all goes well, workable coal ought to be found by the end of the present year, though naturally there is a great deal of other work to be done before coal can be drawn for commercial purposes. There are two shafts, namely, the Tempest and the Vane. Lord Castlereagh cut the first sods on the occasion of his majority celebrations, in December, 1923, and more than two years were occupied in the preliminary operations, including the freezing of the water-bearing strata, through which the shafts pass. Sinking was commenced at the Tempest Pit in February, 1926, but was suspended at the outbreak of the coal strike. Operations were resumed in November, and have been expeditiously pushed forward since, and the shaft has attained a depth of about 500ft., passing through the magnesian limestone into the coal measures. Good progress has also been made with the Vane shaft, where freezing was commenced a little over a week ago. In order to freeze the strata, bore-holes have to be put down around each shaft to a depth of more than 500ft. Each of the shafts has a diameter of 21ft. A railway is to be constructed to connect the new colliery with Seaham docks, and a railway connection has been made with the London and North-Eastern Railway, near Seaham Hall Dene.

Cleveland Iron Trade.

Four additional blast-furnaces have been re-started this week, two at Port Clarence and two at the Teesbridge Ironworks, bringing the total number working on the North-East Coast to 42, as compared with a pre-strike total of 38. There is, however, very little pig iron available for the open market. The great bulk of the output is being used by makers in their own steel works. One firm has now fourteen blast-furnaces operating, and requires the whole of the output for steel making. Generally, makers are doing their best to give deliveries under old contracts, but at a time of such pressure there has to be a little give and take about the distribution of the output. Prices are unchanged, and as forward contracts will be accepted at 2s. 6d. per ton below current rates, there is a substantial inducement to consumers to wait. For prompt home deliveries makers quote 90s. per ton for No. 1 Cleveland foundry iron, 85s. for No. 3 G.M.B., 84s. for No. 4 foundry and 83s. for No. 4 forge. Export inquiries are still very few and far between, but one or two cargoes have been shipped, and in these cases 6d. per ton above the home price is asked.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is improving. There are now a few blast-furnaces producing hematite, and it is less difficult to buy for January and early February delivery. There is a little inquiry from the Continent also, but makers will not sell mixed numbers below 90s. per ton, and in some cases are asking more.

Ironmaking Materials.

The foreign ore trade is becoming active, but supplies are coming to hand very slowly, owing to the scarcity of tonnage at the ore ports. Works are now anxious to arrange deliveries, and there have been a few fixtures from the Mediterranean, but a good deal more tonnage is needed. Odd cargoes are changing hands, but no very large volume of business is reported, and prices are irregular with 23s. per ton still an approximate c.i.f. figure for best Rubio ore. Blast-furnace coke continues very scarce and firm. Some of the makers are asking 27s. 6d. per ton delivered at the works, and 25s. seems to be a bedrock price.

Manufactured Iron and Steel.

Great activity prevails in the manufactured iron and steel trade. The works are going at full pressure, and there is no lack of business. Prices, too, are generally well maintained, though galvanised corrugated sheets are easier and iron ship rivet prices have been reduced by £1 per ton. Shipbuilders still complain of a lack of angles, but steel manufacturers are doing their utmost to overtake the arrears.

The Coal Trade.

The Northern coal trade is moving on very disappointing lines. When the national coal stoppage was nearing its end, the common prophesy was that there would be at least three months of good export trade in replenishing stocks. The forecast has not been fulfilled, so far, in the North of England. There has been very little demand, and now it is exceedingly dull, and some collieries are idle for want of orders. It was not expected that the importation of fuel would have been continued as long as it has been. With thousands of tons of American coal still coming into the country under contracts, and prices weakening from day to day, it is not to be wondered that foreign consumers are holding off until values become more to their liking. The demand is exceedingly quiet at the moment, and unless the position changes for the better, there is going to be difficulty in disposing of current production. Merchants are scouring the Continent for trade, but apart from odd cargoes to meet pressing needs and occasional larger orders for utility companies, there is little being done. In steam coals, all descriptions are daily moving in buyers' favour. Best Northumberland steams are easy at from 18s. 6d. for the second half of January to 18s. for early February. Tyne primes and North Northumberlands have also dropped to 19s. Best Durham steams are just nominally quoted at 24s. There is no improvement to record in steam smalls, supplies of which are plentiful. Best grades are at 12s. 6d.; seconds, 11s.; Tyne primes and other specials, 13s. to 13s. 6d.; best Durham steam smalls are 15s. to 16s.; washed smalls, 18s. In gas coals the trade is also depressed, and it is simply a question of individual bargaining, so far as this month's trade is concerned. Best qualities are offered at 18s. 6d. to 19s., and secondary gas from 17s. to 18s. Durham coking unscreened are also a turn easier than recently. Durham unscreened bunkers remain plentiful; good sorts at 17s. 6d.; best, 18s. to 18s. 6d.; specials, 19s.; and South-West Durham, 16s. 6d. The immediate demand for coke is not much brighter, but makers are taking a more hopeful view of the situation, and a few more coke ovens have been restarted this week. For immediate delivery all makes of coke are ample, and in slow demand. Values, however, are steadily moving towards economic prices, and the demand prospects are improving. Gas coke is quoted 27s. 6d. to 30s.; patent foundry cokes, 25s. to 30s.

Blast-furnacemen's Wages.

Under the sliding scale regulated by the price of Cleveland pig iron, wages of blast-furnacemen on the North-East Coast would have been substantially advanced this quarter, but by arrangement between the ironmasters and the men's representatives they remain at 14·75 per cent. above the standard. The average net selling price of No. 3 Cleveland pig iron for the last quarter of 1926 has been certified at 104s. 4d. per ton, as compared with 83s. 5·9d. per ton for the previous three months.

SCOTLAND.

(From our own Correspondent.)

Improved Outlook.

REPORTS from several districts indicate that there are definite signs of at least a partial revival in the steel and iron trades. Many of the large works have either restarted or are about to do so, after months of idleness, while it is said that work will, in all probability, be restarted at establishments which have been idle for years.

Pig Iron Supplies.

Several pig iron furnaces are now in operation, and the number will soon be increased to sixteen, but some time must elapse before local consumers can be fully supplied. Some consumers prefer to wait while others are utilising continental basic pig iron, which can be obtained at 85s. per ton delivered at Scottish works. Home prices are about 90s. per ton hematite, 95s. No. 1 foundry, and 92s. 6d. per ton No. 3 foundry delivered Glasgow area.

Steel Plates.

There is a growing demand for steel plates, especially on the part of the shipyards, in some of which lack of supplies delays operations. Plentiful supplies of foreign plates are available at prices considerably below home rates, but most consumers prefer to await deliveries of the local product, which is invariably superior in quality.

Steel Sheets.

Sheet makers continue in active employment, and anticipate busy times in the coming months. It has been reported that prices for the cheaper qualities of galvanised sheets have been slightly shaded for the Indian market, but quotations generally show no sign of easing.

Bar Iron.

Bar iron makers are becoming more active. Fair orders are held, and outputs will increase as fuel cheapens. A good turnover is being done in the re-rolled steel department. Bar iron is unchanged in price, while re-rolled steel bars are quoted about £8 15s. per ton.

Coal.

Business in the Scottish coal market showed little expansion during the past week. Most of the collieries resumed work at the middle of last week, but for a few days outputs were very moderate. Prices were upheld at first, but owing to the scarcity of orders an easier tendency became manifest. Consumers, however, continue to ignore anything apart from immediate requirements. Industrial demands are perhaps a shade better, but are still far below normal, while requirements for railways and gas works are, in some instances, still supplied by American fuel, which continues to arrive in comparatively large quantities. There is little doubt that good orders are waiting to be placed, but foreign buyers are evidently disinclined to concede the prices named by merchants. Aggregate shipments from Scottish ports amounted to 133,214 tons, compared with 210,029 tons in the preceding week and 136,942 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE position in the coal export trade is far from being satisfactory, and is causing a good deal of anxiety to coalowners. It is quite true that shipments for the week ending the 7th inst. showed a marked improvement upon the figures for the previous week, when, of course, the quantity was adversely affected by the holidays. The total last week came to rather more than 390,000 tons, which was more than double the total for the preceding week, but it must be pointed out that by far the bulk of the shipments were on old contracts, and that the amount of new business arranged has been comparatively small. Buyers abroad are not showing any eagerness to purchase on the basis of the prices recently ruling, and are, for the most part, holding off. It is not surprising, therefore, that the market has continued to display a declining tendency, so that the values now ruling are very near if not actually down to the level of the cost of production at many undertakings, seeing that outputs are not normal, and that many collieries are unable to work regularly owing to the shortage of empty wagons. The position is very difficult, and undoubtedly the export trade is suffering considerably from the effects of the substantial quantities of coals which are still coming to this country and to European ports, mainly from America. During the past week as many as fourteen steamers have been discharging their cargoes of foreign coals at local ports, and a number of cargoes which were purchased from America before the termination of the stoppage in this country have been re-sold at extremely low prices to local consumers and to continental buyers at prices which must have entailed a very serious loss to the original purchasers, who apparently deemed it advisable to cut their losses. It is stated that in one instance a number of cargoes of American coal have been disposed of amounting to a total of about 50,000 tons at 24s. c.i.f. at one of the French Bay ports, while other cargoes, amounting altogether to about 30,000 tons, have been sold to one of the French railways at 22s. c.i.f. North French ports. In the case of American coals which have arrived at local ports, it is understood that industrial consumers in the Swansea district have recently bought supplies at the low figure of 17s. on ship. Reports on the market are that some of the coals now coming in from abroad are almost unsaleable. It is not surprising in the circumstances prevailing that the conditions locally are difficult because the wagon question becomes a very serious problem. Not only are the collieries suffering from a shortage of rolling stock resulting in pits being idle, but the market is being weakened for supplies of coal for prompt shipment.

Coalowners and Advertising.

During the past year especially, foreign coal producers have taken every possible step to push their coals into the markets, which were formerly held by Welsh coals, and it is realised that something in the nature of counter propaganda will have to be undertaken in view of the keener competition which will almost certainly have to be faced in the future. The time when local coalowners could rely on Welsh coals practically selling themselves, has to a very large extent gone by. Something more will have to be done to bring the merits of Welsh coals to the notice of foreign consumers. The secretary of the South Wales Coalowners' Association has issued a circular to the members of the Association suggesting that a brochure relating to the South Wales coalfield should be issued, and that a Committee, representing coalowners, exporters, shipowners and the Great Western Railway Company should be formed for the purpose of dealing with matters relating to the export trade. The circular adds that reports of the coal trade of the world show that every coal producing country is concentrating upon bringing its coals to the notice of consumers and in marketing them in the best possible condition to meet the requirements of customers.

Ships Changing Docks.

In March, 1925, the Great Western Railway Company decided that vessels changing docks within Cardiff, Penarth and Barry should be subject to one tonnage rate only, plus a locking fee, whereas previously vessels had to pay their dues at each dock, although they might only have moved from one to the other for the purposes of loading or discharging their cargo. Naturally shipowners highly appreciated this concession, but Newport traders resented its being limited only to the port of Cardiff. The result ultimately was that the concession was withdrawn altogether instead of being extended to other ports in this district. However, the matter is being taken up again, and there is to be a meeting next week in London between Sir Felix Pole, the general manager, and Mr. C. S. Page, chief docks manager of the Great Western Railway, and representatives of the Cardiff and Bristol Channel Shipowners' Association.

Coalfield Items.

Following on the unfortunate events attending the meeting of the Coalfield Disputes Committee last week, when the miners' representatives abruptly terminated the proceedings, the Executive Committee of the South Wales Miners' Federation has decided to call a coalfield conference to consider the position, but in the meantime the coalowners' secretary is to be asked to call an early meeting of the full Conciliation Board for the purpose of seeing if steps cannot be taken to remove the grievances of the workmen. The local Federation is endeavouring to rebuild its organisation, and a circular has been sent to all lodges in which it is proposed that all arrears of contributions of individual members shall be cancelled, and that the first contribution payable to the Federation should be as from December 6th last, and that no assistance or protection should be given by the Federation to any workman who has been in employment for four weeks or more unless he has paid his contributions. The leaders of the South Wales Miners' Federation are making light of the new miners' movement of a non-political character, but it is just likely that the opposition will be stronger than they care to admit. A meeting of the executive of the new organisation, called the South Wales Miners' Industrial Union, was held at Trelewis last week, and it was then reported that a number of new branches had been formed, bringing the total number in this district up to thirty.

"P.D." Appointments.

The directors of the Powell Duffryn Steam Coal Company, Ltd., have appointed Mr. Edmund Lawrence Hann deputy chairman and managing director, and his brother, Mr. Douglas A. Hann, as general colliery manager. Mr. Edmund L. Hann was formerly the general colliery manager. He is the third son of Mr. E. M. Hann, a former general manager of the Powell Duffryn Company, and is acknowledged to be one of the most brilliant mining engineers in the country. He is the chairman of the Monmouthshire and South Wales Coalowners' Association, a member of the Council of the Institution of Mining Engineers, and of the South Wales Institute of Engineers. In 1924 he was awarded the gold medal of the South Wales Institute of Engineers.

Great Western Railway Marine Department.

Following upon the retirement of Captain H. Sharp, marine superintendent of the company, the Great Western Railway Company has amalgamated that department as from January 1st with the docks department and placed it under the control of the chief docks manager, Mr. C. S. Page, at Cardiff. Formerly the department had been separately responsible for the running and maintenance of the passenger boats of the company plying between Fishguard and Ireland and between Weymouth and the Channel Islands, as well as the maintenance of the tenders which wait upon the liners calling at Plymouth, &c. Up to the end of last year the headquarters of the department were at Fishguard, but they have now been transferred, together with the greater part of the staff, to Cardiff.

Current Business.

There has not been a great deal of fresh business passing on the market during the past week, but a fair amount of discussion has been given to the question of the proposed increase in railway rates, which, of course, will affect coal. It will not be, in all probability, a very heavy burden, and is estimated to amount to about 1·33d. per ton in this district on coal from pit to port, but it is unfortunate that any additional impost should come at this time when every incentive should be given to traders to recover trade. The market for prompt loading of coals is for the most part on the easy side. Even the best Admiralty large coals have fallen to about 26s., while smalls have declined to 14s. in the case of superior sorts, though with the irregular working of many pits owing to the lack of empty wagons, supplies of smalls are becoming scarcer, and the price shows a tendency to recover. Some salesmen are now asking 15s. for their small coals. There is no change in patent fuel, but pitwood is weaker and is quoted at about 26s. to 28s. This market is also adversely affected by the lack of rolling stock.

CONTRACTS.

JOSEPH KAYE AND SONS, Ltd., of Lock Works, Leeds, have recently received from the Great Western Railway Company a large repeat order for their latest patented automatic carriage door wedge locks complete with combined cam striking plates.

THE Traction Department of the General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2, has received an order from the Croydon Corporation for ten sets of tramcar electrical equipments, each set comprising, amongst other items, two motors each rated at 65 B.H.P., and two special cam type controllers.

HUNTINGTON, HEBERLEIN AND CO., Ltd., of 47-51, King William-street, London, E.C. 4, have secured a contract for the supply of two sulphuric acid oleum plants of the latest type, one being for the Assam Oil Company and the other for the Burmah Oil Company, Ltd. The tenders were open to foreign competition, and it is, therefore, gratifying that a British firm of chemical engineers should have been entrusted with this work. The plants will be of British design and manufacture throughout.

INTERNATIONAL COMBUSTION, Ltd., have been appointed main contractors for the Perak hydro-electric power station and will be responsible for all buildings, cranes, boilers, and pulverised fuel equipment, for the station, which is to be of 12,000 kilowatts capacity. The same firm has also received from the Anglo-Persian Oil Company an order for an extension of the boiler-house plant at the Abadan Refineries, Persia; and an order for "Raymond" pulverising and transporting equipment for the firing of a continuous billet reheating furnace of 6 tons per hour capacity for a steel works in the North of England.

THE METROPOLITAN-VICKERS Electrical Company has received from the Liverpool Corporation an order for a second 25,000-kW. set for the Lister Drive No. 3 power station. The set, which is a duplicate of that which the company supplied last year, includes a turbine and alternator, together with complete condensing plant and auxiliary apparatus. The set is for operation at 1500 r.p.m., and the turbine will be designed for a steam pressure of 275 lb. per square inch gauge, with steam superheated to 675 deg. Fah. and a vacuum of 27·6in. at full load. The alternator is to give its rated output at 6300 volts, 50 periods, 0·8 power factor, and will be ventilated on the Metropolitan-Vickers patented closed-circuit system.

THE PULSOMETER ENGINEERING COMPANY, Ltd., of London and Reading, has received from the London and North-Eastern Railway Company an order for the supply, delivery and erection of electrically driven hydraulic pressure pumps, return water pumps, meters, pipes, valves, &c., for the No. 1 pumping station at Alfred-street, Kingston-upon-Hull. The hydraulic pressure pumps will consist of four Pulsometer double-unit turbine centrifugal pumps, two of which will each be capable of delivering 800 gallons of water per minute, against a total head equivalent to a pressure of 850 lb. per square inch (1960ft.), the other two each being capable of delivering 600 gallons of water per minute, against the same head. The whole of the pumping plant will be operated by air break automatic control gear.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 10 0	—
No. 1 Foundry	4 15 0 to 5 0 0	—
No. 3 Foundry	4 12 6 to 4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	c4 10 0	4 10 0
No. 1	c4 11 0	4 11 0
Cleveland—		
No. 1	c4 10 0	4 10 6
Silicious Iron	c4 10 0	4 10 6
No. 3 G.M.B.	c4 5 0	4 5 6
No. 4 Foundry	c4 4 0	4 4 6
No. 4 Forge	c4 3 0	4 3 6
Mottled	c4 2 0	4 2 6
White	c4 2 6	4 2 6

(c) *January - February Delivery.*

MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	4 0 0 to 4 2 6	
„ Forge	—	—
(3) Derbyshire—		
No. 3 Foundry	4 5 0	—
Forge	—	—
(3) Lincolnshire—		
No. 3 Foundry	4 5 0	—
No. 4 Forge	—	—
Basic	3 17 0 to 3 18 0	
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (a) / 4 18 6 (b) / 5 2 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 15 0	11 10 0
Best	—	—
N.E. COAST—		
Common Bars	12 5 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 5 0 to 11 10 0	
Gas Tube Strip	15 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up	8 7 6	7 0 0
Sections	7 17 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	12 10 0 to 13 10 0	
Sheets (Gal. Cor. 24 B.G.)	—	£16 10 0 to 17 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 17 6	—
Angles	8 12 6	—
Boiler Plates	12 10 0	—
Joists	8 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 0 0	—
„ (Small Round)	9 5 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 17 6 to 9 0 0	
„ (Lancs. Boiler)	11 15 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	8 0 0	—
Hoops	12 0 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 5 0	—
Angles	8 0 0	—
Joists	8 0 0	—
Tees	9 0 0	—
Bridge and Tank Plates	8 17 6 to 9 2 6	
Boiler Plates	—	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/3 to 21/-
Block Tin (cash)	293 10 0
„ (three months)	293 15 0
Copper (cash)	55 12 6
„ (three months)	56 7 6
Spanish Lead (cash)	27 15 0
„ (three months)	28 1 3
Spelter (cash)	31 15 0
„ (three months)	31 13 9
MANCHESTER—	
Copper, Best Selected Ingots	62 10 0
„ Electrolytic	63 2 6
„ Strong Sheets	90 0 0
„ Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 0
„ Condenser lb.	0 1 2½
Lead, English	29 5 0
„ Foreign	28 2 6
Spelter	31 17 6
Aluminium (per ton)	£107

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 12 6	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 0 0	12/6
„ „ „ 1 p.c. „	£42 0 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 7 6 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 6/- per unit	
„ Vanadium	14/6 per lb.	
„ Molybdenum	5/- per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	8/6 per lb.	

FUELS.

SCOTLAND

(*Prices not stable*).

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	19/-
„ „ Ell	21/-
„ „ Splint	22/6 to 24/6
„ „ Trebles	23/-
„ „ Doubles	20/6
„ „ Singles	18/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	19/-
„ „ Jewel	22/-
„ „ Trebles	23/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	17/6 to 19/-
Screened Navigation	23/6
Trebles	23/- to 26/-
Doubles	20/6
Singles	19/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	18/-
Secondary Steam	17/6
Trebles	23/-
Doubles	20/-
Singles	18/6

ENGLAND.

	Export.
(8) N.W. COAST—	
Steams	28/-
Household	*No quotation.*
Coke	32/6
NORTHUMBERLAND—	
Best Steams	18/6
Second Steams	17/6 to 18/-
Steam Smalls	14/-
Unscreened	17/- to 17/6
Household	30/- to 36/-
DURHAM—	
Best Gas	18/6 to 19/-
Second	17/6 to 18/-
Household	30/- to 36/-
Foundry Coke	25/- to 27/6

	Inland.
SHEFFIELD—	
Best Hand-picked Branch	34/- to 35/-
Barnsley Best Silkstone	30/- to 32/-
Derbyshire Best Brights	30/- to 32/-
„ „ House	28/- to 30/-
„ „ Large Nuts	27/- to 29/-
„ „ Small	22/- to 24/-
Yorkshire Hards	19/- to 21/-
Derbyshire Hards	19/- to 21/-
Rough Slacks	12/- to 12/6
Nutty Slacks	8/6 to 9/6
Smalls	3/- to 6/-
Blast-furnace Coke (Inland)	20/- at ovens.
„ „ (Export) f.o.b.	26/- to 27/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	26/- to 27/-
Second „ „	24/6 to 25/6
Best Dry Large	23/6 to 24/6
Ordinary Dry Large	22/- to 23/-
Best Black Vein Large	24/6 to 25/-
Western Valley Large	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/-
Ordinary „ „	23/- to 23/6
Best Steam Smalls	14/6 to 15/6
Ordinary „	11/- to 14/-
Washed Nuts	24/- to 29/-
No. 3 Rhondda Large	29/- to 30/-
„ „ Smalls	18/- to 19/-
No. 2 „ Large	24/- to 25/-
„ „ Through	20/- to 21/-
„ „ Smalls	15/- to 16/-
Foundry Coke (export)	45/- to 65/-
Furnace Coke (export)	30/- to 35/-
Patent Fuel	29/- to 31/-
Pitwood (ex ship)	25/- to 26/-
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	45/- to 47/6
Seconds	35/- to 40/-
Red Vein	30/- to 32 6
Machine-made Cobbles	50/- to 55/-
Nuts	57/6 to 62/6
Beans	47/6 to 50/-
Peas	27/- to 29/-
Breaker Duff	10/6 to 11/-
Rubbly Culm	15/- to 16/-
Steam Coals :	
Large	24/- to 25/-
Seconds	23/- to 24/-
Smalls	11/- to 14/-
Cargo Through	19/- to 20/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. † Latest quotations available.

(a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Manufacturing Costs.

THE situation, so far as it has gone, points clearly to the necessity of manufacturers bringing down costs if they are to maintain their connection with foreign markets. The effect of the higher value of the franc is to increase considerably the cost of French products in markets abroad, while at home the cost of manufacture has been little affected, because the purchasing power of the franc in its relation to home products does not increase so long as the same wages have to be paid and industry is burdened with higher taxation, although it has an advantage in diminishing the cost of imported raw material. The result is that the prices of imported goods fall immediately, while those of home products decline slowly to a much less extent. The ironfounders and other firms in the Ardennes have closely investigated the matter and have come to the conclusion that the only solution lies in the supply of cheaper fuel. They urge upon the Government to take such steps as are necessary to insure a reduction of coal prices, but as French coalowners have decided to maintain their prices any action of the Government can hardly prove effective unless it can offer compensating advantages. Consumers are well aware that there can be no hope of cheaper fuel until the supplies from Britain become normal again, when competition will have the effect of weakening prices all round. Cheaper fuel will do something, but it will not solve the problem. So complex is the situation that manufacturers find it necessary to change their industrial methods completely, and a General Commission for the scientific organisation of work has been formed in order to carry on propaganda in favour of more rational forms of work and of the complete suppression of waste. Sub-commissions are dealing with the various aspects of the problem, such as industrial production, purchases and sales and works organisation, and others will collect data, publish reports and do what is necessary to bring all available information to the notice of manufacturers.

Railway Centenary.

The town of Saint-Etienne will celebrate this year the centenary of the opening of the first railway between Saint-Etienne and Andrézieux and will, at the same time, unveil a statue to Marc Séguin. The construction of the railway for carrying coal to the Loire and the Rhone was proposed by an engineer, Monsieur Le Gallois, who had visited the English collieries, and the final plans were prepared by another engineer, Monsieur Beaunier, the concession for the work being obtained in 1823 and the railway completed four years later. Meanwhile, arrangements had been made to construct another railway between Saint-Etienne and Lyons, and with that was associated the name of Marc Séguin, who imported two Stephenson locomotives to serve as models for the construction of similar machines in France. Marc Séguin found that they were too heavy and the speed too low. He therefore built a locomotive with fire tube boiler which was tried on November 7th, 1829. Within 36 minutes of firing the locomotive is said to have drawn four trucks containing 15 tons of pig iron. It was stopped on up-gradients and restarted under conditions that were declared to be highly satisfactory. Marc Séguin also replaced the cast iron rails employed in England by rails of rolled iron and employed wooden sleepers. For several years it was debated whether it was advisable to suppress animal traction, which was still used on the steeper gradients, and it was only in 1844 that that was done, and the traffic dealt with entirely by steam locomotives, the distance between Saint-Etienne and Lyons being covered in 22 hours 35 minutes, including stoppages. The company building the line secured with the concession the right to impose a perpetuity tax upon the coal and other goods carried. At the time the concession was granted there was no question at all of the railway being used for passenger traffic.

The Steel Union.

Information is received from Germany to the effect that British steelmakers have expressed their willingness to discuss the conditions of their becoming members of the Steel Cartel, and that a meeting for that purpose will be held early next month. From the same source it is declared that if British firms have held aloof it is solely because they could not accept the participation of something less than 9,000,000 tons that was offered to them instead of the minimum of 10,000,000 tons they claimed.

Public Works.

The arrangements being made for putting in hand public works for the relief of unemployment, if the crisis should assume serious proportions, involves the supply by Germany of a considerable quantity of machinery on account of reparations, and that is naturally causing discontent amongst French manufacturers, who declare that it is absurd to give employment to German firms when they themselves are in need of work and when they could, if in possession of such orders, give employment to the men for whose benefit the various enterprises are to be carried out. Unfortunately, there is no hope of getting anything from Germany except in the form of machinery and material, and it is hardly possible that the Government could find the means to carry through the programme in any other way. As it is, the Government hopes to take advantage of this opportunity to complete the vast scheme of hydraulic, canal, harbour, railway and other works which was drafted some years ago with a view of securing German aid for perfecting the economical equipment at home and in the Colonies. The Nancy Chamber of Commerce claims that preference should be given to the tunnelling of the Vosges, which it declares to be of primary strategical importance as well as necessary for the development of trade between Alsace and the rest of France. The difficulty of relying upon German firms for material if the price is not satisfactory is seen in the order for 2000 trucks, which was placed in Germany nearly two years ago. The order was split up and passed on from one maker to another and only small numbers of trucks have been delivered. A part of the order has now been cancelled, and 500 trucks are to be supplied by French builders who are at present practically destitute of work.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

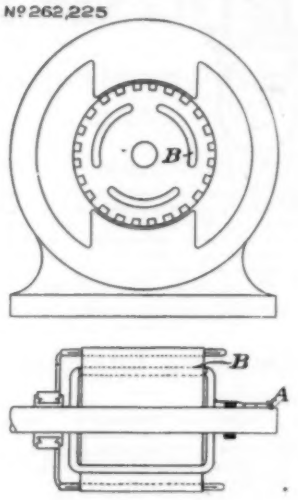
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

262,225. October 14th, 1925.—IMPROVEMENTS IN AND RELATING TO DIRECT-CURRENT MOTORS, Frederick Newton, of Alfreton-road, Derby.

Means are described in this specification for maintaining the speed of a direct-current motor constant under varying conditions of load and varying E.M.F. of supply. A switch A, operated by centrifugal force, is used to close a circuit upon the armature and so cause the generation of an alternating current,

Nº 262,225



the magnetising effect of which is superimposed upon the field due to the normal direct-current field and armature currents. It is desirable to employ a circuit in which the alternating current generated will lag nearly 90 deg. behind the generating E.M.F. In addition to the usual slots and winding, the armature is provided with tunnels B, which accommodate a three-phase winding or a single-phase winding, which is brought into operation by the centrifugal switch A.—*December 9th*, 1926.

SWITCHGEAR.

252,145. April 29th, 1926.—IMPROVEMENTS RELATING TO MEANS FOR PARALLELING ALTERNATING-CURRENT MACHINES OR CIRCUITS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

A scheme is described in this specification for connecting alternating-current generators in parallel when the conditions are suitable. The switch B, which connects the generator A to the alternating-current bus-bars C, is under the control of a solenoid D, which is energised from a direct-current source when the relay E is operated. Transformers F and G are con-

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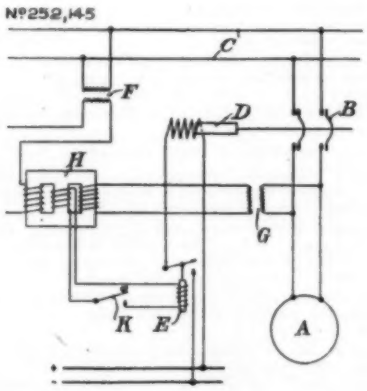

nected as shown to a third transformer H. The primary windings of this transformer oppose one another when the voltages of the two systems are in phase and assist one another when the two systems are in opposition. The secondary winding of the transformer is wound on the central limb, and it is energised to the maximum extent when the voltages of the two systems are in phase. When the switch K is closed the relay E, which is provided with a dashpot, closes its contacts, when the two systems are in phase, and it will readily be seen that the main switch B also closes.—*December 9th*, 1926.

TELEGRAPHS AND TELEPHONES.

240,848. September 30th, 1925.—MEANS FOR THE GRID BACK COUPLING OF VALVE TRANSMITTERS, Telefunken Gesellschaft für drahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, Berlin, Germany.

According to this invention, the correct grid voltage is obtained by transforming down the anode alternating voltage to the value suitable for the grid with the aid of a tight coupled transformer. The primary of this transformer is connected directly across the frequency-determining output circuit and the secondary forms the external grid circuit. Alternatively, the correct grid voltage may be obtained by means of a tight coupled transformer, with its primary in the anode supply circuit, which has its mid point connected through a condenser to the tuned output circuit, the secondary forming the grid external circuit. The upper illustration shows one method of carrying out the invention, in which V is the oscillation valve, B the oscillation circuit coil provided with various taps P for the anode connection, and Q for the wave adjustment. C is a condenser variable in stages or continuously for adjusting the wave length, D the anode blocking condenser, E the anode

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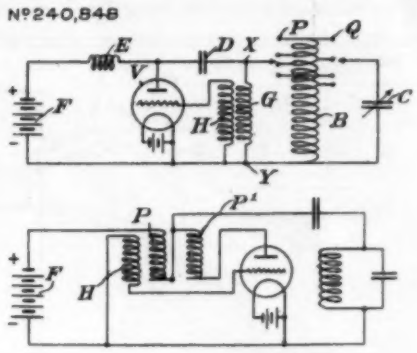


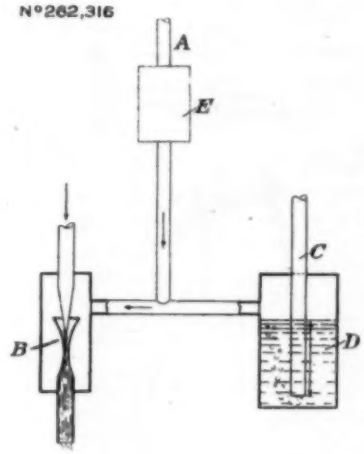
choke which should prevent a high-frequency short circuit over the source F of direct current, G is the primary winding of the coupling transformer which is connected at the points X Y. H is the secondary winding connected to the grid. In a transmitter having high anode direct current, the coupling transformer may be used for lessening the oscillation circuit alternating voltage. Such an arrangement is shown in the lower diagram, in which P and P¹ are two parts of the primary winding of the tight coupled transformer, while H is the secondary winding connected to the grid.—*December 9th*, 1926.

MEASURING AND TESTING INSTRUMENTS.

262,316. March 23rd, 1926.—FLUE GAS RECORDERS, G. Socolov-Vishnevsky, 3rd July-street No. II., Leningrad, Russia.

This apparatus is intended to produce a constant vacuum, by means of a water jet, for providing a supply of flue gases to an analysing and recording apparatus. The flue gas is brought in

Nº 262,316



by the pipe A and is aspirated by the water jet B. The extent of the suction produced is regulated by the depth of immersion of the pipe C in the liquid D, as any excessive suction by the jet will merely draw in atmospheric air by way of the pipe C. E is, of course, the analysing and recording apparatus.—*December 9th*, 1926.

CRANES AND CONVEYORS.

262,317. March 27th, 1926.—LEVEL LUFFING CRANES, A. E. Hawks, 35, Devonshire-place, Jesmond, Newcastle-on-Tyne, and J. E. Spencer, Threepwood Hall, Haydon Bridge, Northumberland.

This crane is of the type in which the jib is articulated in

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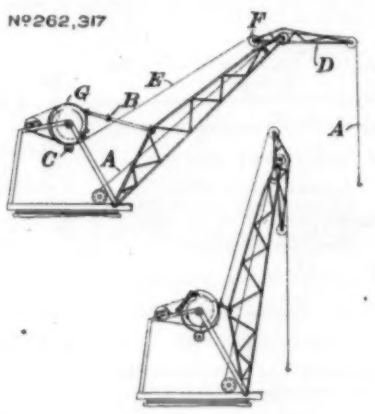

order to produce a level luffing effect, and the aim of the inventors is to arrange the various members in such a manner as to balance the weight of the load against the tendency of the jib to fall forward. The hoisting rope is shown at A A, and the

jib is luffed by means of the connecting-rods B and the pinion C. The angular position of the jib lever D is controlled by the rope E which runs over the sheave F, is attached near the ends of the jib and is wrapped round cam-shaped plates G connected with the luffing gear.—*December 9th*, 1926.

262,322. April 19th, 1926.—EXCAVATING MACHINES, W. Savage and Ruston and Hornsby, Lincoln.

It is noteworthy that while the mechanism of this excavator or navvy is particularly put forward as being convenient for operation by a non-reversible oil engine, the drawing shows a steam boiler. The machine has the usual jib and bucket arm, but the hoisting rope A is carried over a hinged lever B at the end of the jib. This lever terminates in a quadrant C, over which

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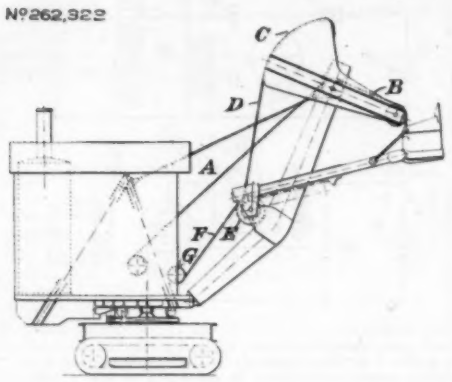

a second rope D is wrapped. The rope D also goes round a drum on the racking gear E, while a third rope F connects a corresponding drum on the gear with the secondary winding drum G. By holding the brake on the drum G the racking gear is kept inoperative; if the brake is slacked off the pull of the rope D works the racking gear to increase the bite of the bucket; and, if power is applied to the drum G to pull in the rope F, the racking gear is so worked as to retract the bucket arm.—*December 9th*, 1926.

SHIPS AND BOATS.

262,349. July 7th, 1926.—SCREW PROPELLERS, *H. C. Heide, 2, Broad-street Buildings, Liverpool-street, London, E.C.* 2.

The inventor aims at minimising the radial dispersion of the slip stream of marine propellers by using blades set to a pre-

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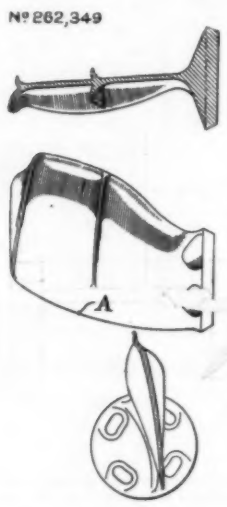

determined pitch from their entering edges to a point intermediate their width and being curved along their trailing edges. The blades are also provided with fins on both faces, as shown in the drawing. The leading edge of the blade is indicated by A.—*December 9th*, 1926.

MISCELLANEOUS.

261,594. February 15th, 1926.—A PROCESS FOR OBTAINING FUELS FROM COAL AND OIL MIXTURES, W. E. Trent, 1131, Whitehall Building, 17, Battery-place, New York.

The inventor says that by grinding wet coal to a fineness of

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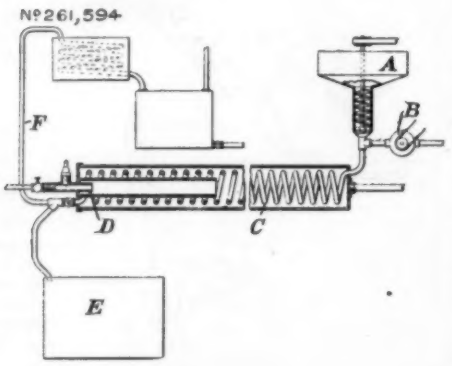

200 mesh and agitating it with from 15 to 20 per cent. of hydrocarbon oil it may be formed into a plastic mass, which excludes water and non-carbonaceous matter. This mass is fed into the hopper A and, together with a supply of "gas, liquid, steam, oil or water," supplied by the pump B, is forced through the spiral pipe C, which is heated to a temperature of about 600 deg. Fah. by the burner D. The carbonised residue is dumped into the receptacle E while the distilled oils and gases go off by way of the pipe F to be condensed. Such oil as is necessary for the process is returned to the primary coal mixer.—*November 25th*, 1926.

253,858. October 26th, 1925.—IMPROVEMENTS RELATING TO THE SECURING OF CABLES, PARTICULARLY THOSE OF MINE SHAFTS, H. Hinzer and Co., Fabrik für Elektrische Apparate, G.m.b.H., of 35, Rüttenscheiderstrasse, Essen, Germany.

With the aid of the device described in this specification cables in mine shafts can easily be placed in position and released when

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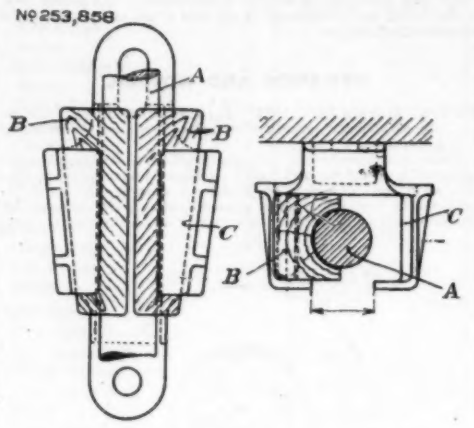

necessary. The cable A is wedged between two wooden wedges B fitting into tapering conical surfaces C of the holder. As the slot in the front of the holder is wider than the diameter of the cable, the latter can readily be placed in the holder, when it is held firmly in position by the wedges. There are six other illustrations.—*November 25th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP.—Chemical Society's Lecture Hall, Burlington House, Piccadilly, London, W. 1. Paper, "Thermo-electric and Resistance Pyrometry in Industry," by Mr. J. Ainger Hall. 8 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. "Gas Furnaces and their Heating," by Mr. P. Hopkinson. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Metallurgical Department, University College, Singleton Park, Swansea. Discussion on "Pyrometers." 7.15 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "The Internal Combustion Boiler and its Application to the Locomotive," by Mr. O. Brunler. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. "The Thermionic Valve and its Characteristics," by Mr. R. L. Kirlew. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Room 14, Temperance Institute, Keighley. "The Steam Locomotive," by Captain Harrison. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Annual dinner.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. "Progress in Economy of Turbine Machinery on Land and Sea," by Sir Charles Parsons and Mr. R. J. Walker. 6 p.m.

SATURDAY, JANUARY 15TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Greenwood's Rooms, 198, Todmorden-road, Burnley. Annual social gathering. 5 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Manchester. Presidential address, "My Impressions of American Foundries," by Mr. W. Jolley. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the operating machinery and plant at the Tower Bridge, London, E. 1. 2.15 p.m.

SOCIETY OF GERMAN FOUNDRYMEN.—Of Berlin N.W. 7, Friedrichstrasse 100. Four lectures on the "Electric Furnace," to be given at the Technical High School, Charlottenburg. (1) "Reaction Processes in Electric Furnaces of the Basic Type," by Dip.-Ing. K. v. Kerpely; (2) "The Economy of the Electric Furnace in the Foundry," by Professor Dr. Kothny. (3) "Demonstration of an Induction Type Furnace with Lecture," by Dr.-Ing. Fischer; (4) "Questions Relating to the Price of Current," by W. Schaefer. 10.30 a.m.

MONDAY, JANUARY 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "Electric Lighting for Public Service Vehicles," by Mr. A. N. May. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor lecture, "Recent Progress in Optics," by Dr. L. C. Martin. 8 p.m.

TUESDAY, JANUARY 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, The "Problem of Selling Cars," by Mr. R. N. Aveline. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—The Temperance Hall, Temple-street, Birmingham. Annual Film Exhibition. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-WESTERN CENTRE.—Midland Hotel, Manchester. Annual Dinner. 6.45 for 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Smokes as Aerial Disperse Systems," by Professor R. Whytlaw-Gray.

WEDNESDAY, JANUARY 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Junior Institution of Engineers, 39, Victoria-street, London, S.W. 1. Informal meeting. Exhibition of cinematograph films. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Engine Cooling," by Mr. A. L. Bate. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. Lecture, "The Testing of Heat Engines," by Mr. H. R. J. Burstall. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—36, George-street, Manchester. Paper, "Pumping Machinery of the Manchester Water Works," by Mr. J. P. Hallam. 6.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—The University, Edmund-street, Birmingham. Paper, "Electrical Equipment of Track on the Underground Railways of London," by Mr. A. R. Cooper. 7 p.m.

MANCHESTER METALLURGICAL SOCIETY.—The Engineers' Club, Manchester. Paper, "Die Castings," by Mr. A. H. Mundey. 7 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, London, S.W. 7. Annual general meeting. Address, "The Atlantic Ocean," by Sir Gilbert Walker. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Development of the Petroleum Industry in Persia," by Professor Sir John Cadman. 8 p.m.

THURSDAY, JANUARY 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. Graduates' meeting. Paper, "Mixture Distribution in Multi-cylinder Petrol Engines," by Mr. J. N. H. Tait. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Hotel Metropole, Leeds. Paper, "The Construction of Sewers in Tunnel," by Mr. J. Clemishaw. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C 2. Paper, "33,000-volt Cables with Metal-Sheathed Cores, with Special Reference to the S.L. Type," by Mr. P. Dunsheath. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-WESTERN BRANCH.—The Engineers' Club, Manchester. Annual general meeting. Paper, "Steam Turbines," by Mr. G. Arrowsmith. 7.15 p.m.

FRIDAY, JANUARY 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Technical College, Derby. Derby Graduates' meeting Paper, "Duralumin," by Dr. L. Aitchison. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Paper, "The Use and Economy of High-pressure Steam Plants," by Professors A. L. Mellanby and W. Kerr. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Exhibition of Scientific Instruments and Apparatus. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Tyndall's Experiments on Magne-Crystallic Action," by Sir William Bragg. 9 p.m.

MONDAY, JANUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Carburetters," by Mr. Short. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, Westminster, London, S.W. 1. Lecture, "Mechanical Engineering in the Army in Relation to the Duties of an Ordnance Mechanical Engineer," by Major A. R. Valon. 7 p.m.

TUESDAY, JANUARY 25TH.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "The Development of Industrial Welfare Work," by Rev. R. R. Hyde. 7.30 p.m.

WEDNESDAY, JANUARY 26TH.

FARADAY SOCIETY.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers, "The Behaviour of the Quinhydrone Electrode in Solutions of Neutral Copper Sulphate," by Mr. J. B. O'Sullivan; "The Actinic Absorption of Chlorine Gas with Respect to the Hydrogen Chlorine Reaction," by Mr. W. Taylor; "The Residual Effect in the Actinic Absorption of Chlorine," by Messrs. W. Taylor and A. Elliott; "Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part II.," by Messrs. W. R. Harrison and E. P. Perman; "The Electrostatic Capacity of Aluminium and Tantalum Anode Films," by Messrs. N. A. de Bruyne and R. W. W. Sanderson; "On the Velocity of Chemical Reaction in the Silent Electric Discharge," by Messrs. G. A. Elliott, S. S. Joshi and R. W. Lunt; "The Activation of Hydrogen in the Electric Discharge," by Mr. G. A. Elliott; "The Soret Effect," by Mr. C. C. Tanner; "An Improved Method of Measuring Vapour Pressure by Air Bubbling," by Messrs. H. I. Downes and E. P. Perman. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Birmingham Graduates' visit to the Works of the Austin Motor Company, Ltd., at Northfield. 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—The Engineers' Club, Albert-square, Manchester. Paper, "The Optical Indicator as a Means of Examining Combustion in Internal-combustion Engines," by Professor W. Morgan. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Engineering and Scientific Club, Queen-street, Wolverhampton. Lecture, "The L.G.O.C. Methods of Repairing Motor Omnibuses," by Mr. G. Rushton. 7.30 p.m.

NEWCOMEN SOCIETY.—Demonstration Room A1, The Science Museum, South Kensington, London, S.W. 7. Papers, "Trevithick and Rastrick and the Single Acting Expansive Engine," by Mr. A. Titley; and "A Note on Newcomen's Handwriting," by Mr. Rhys Jenkins. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "British and American Practice in the Working of Hot and Cold Metals," by Mr. F. W. Spencer. 8 p.m.

THURSDAY, JANUARY 27TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Training School of Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "Some Notes on a Practical Experience of the Single Sleeve Valve Principle," by Mr. G. L. Ensor. 7.30 p.m.

FRIDAY, JANUARY 28TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Discussion on "Mass Production as Applied to the Repairing of Locomotives," opened by Mr. S. Symes. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W 1. Paper, "The Design of High-tension Substations," by Mr. C. E. Atkinson. 7.30 p.m.